FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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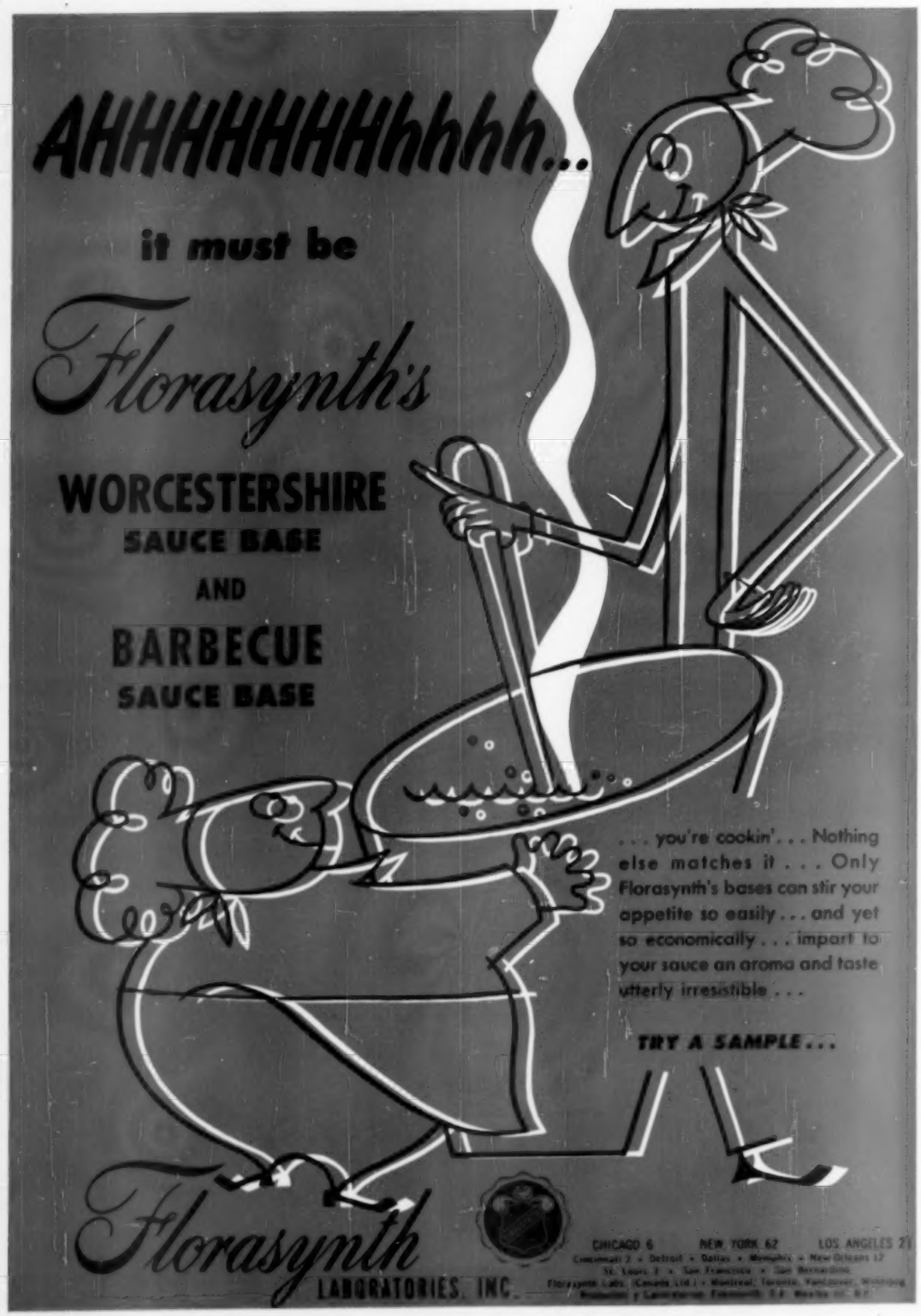
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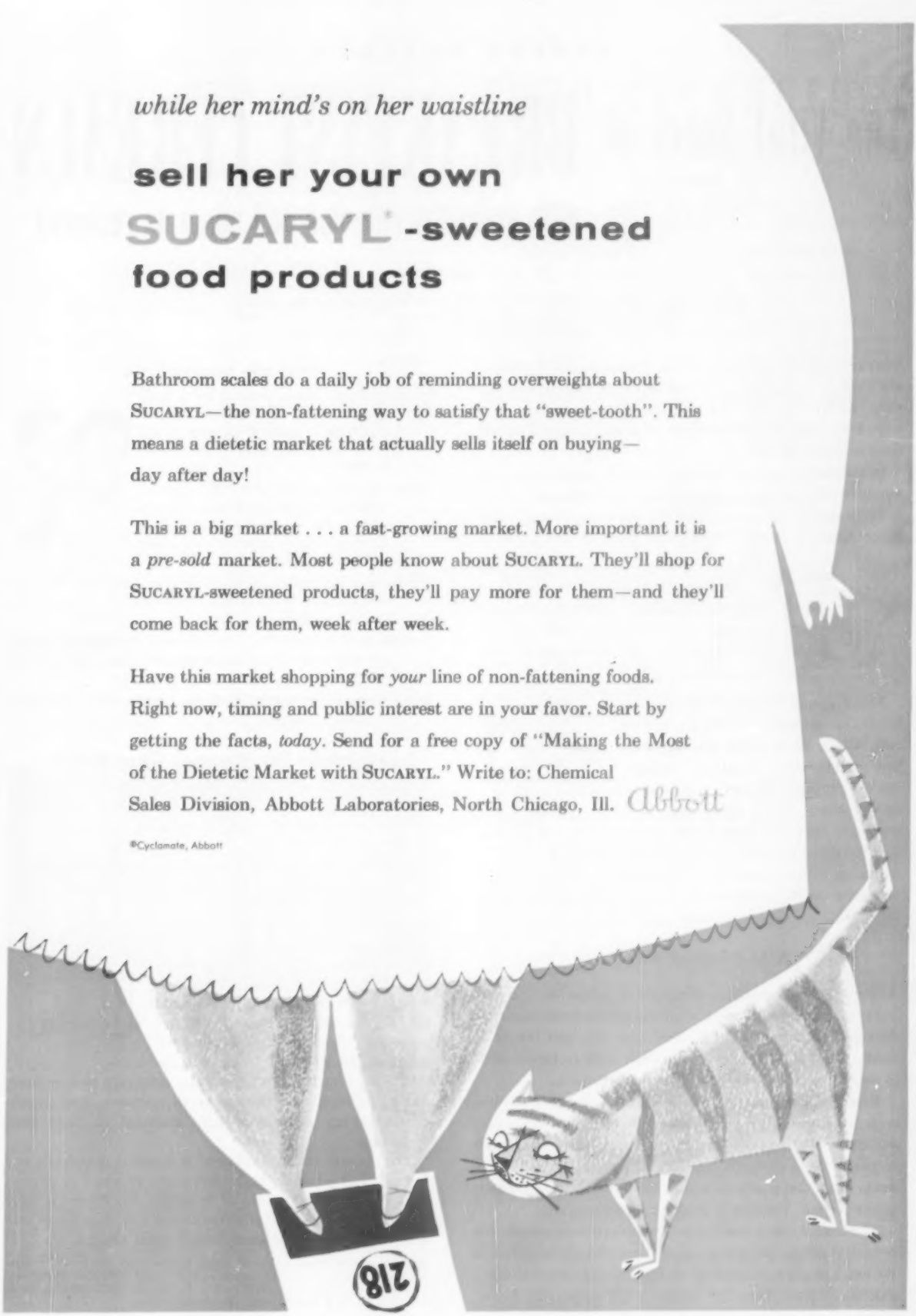


The Vital Story of BREAKFAST CEREALS

with essential vitamins and minerals restored

by Science Writer

This article is one of a series devoted to the story of vitamin enriched or restored cereal products: white bread and rolls, white flour, corn meal and grits, macaroni products, white rice, breakfast cereals, farina.

Increasing in popularity over the years, breakfast cereals are used throughout the United States by young and old alike. Eaten with fruit and milk or light cream, they contribute an excellent combination of basic, flavorful, nutritious foods to the diet.

In the past decade the use of these fine foods has grown markedly. In fact, it is estimated that there has been a 20% increase during the period. In 1953 the increase was much higher than the average of previous years. It was 5.5%.

During 1953, for example, many tons of breakfast cereal foods were eaten in the United States. Industry figures show that 4.6 pounds of dry cereals and 2.5 pounds of hot (cooked) cereals per person were consumed.

Many grains are processed to make breakfast cereals: wheat, corn, rice, oats. Often these foods may be eaten just as they come from the manufacturer's package. Or they may require only a short period of cooking to be ready for the table. They appeal to busy home-makers, as well as to institutional dietitians, because they are readily available in a variety of flavors to add interest and value to an important, but sometimes neglected, meal.

A Nutritional Advance

As the science of nutrition advanced in recent years, it was found that losses of essential vitamins and minerals occurred during processing of wheat, corn and rice into breakfast foods. When this became known, most manufacturers acted to overcome the losses. They adopted restoration.

Restoration simply means that certain vitamins and minerals are added to the cereal food during processing so that the finished product is generally equal to the whole grain values of those elements. The vitamins thiamine (B_1), riboflavin (B_2), and niacin as well as the mineral, iron, are used in restoration. Vitamin D is also added sometimes.

The recent trend toward pre-sweetened cold cereals for breakfast consumption and between-meal snacks emphasizes the nutritional importance of vitamin fortification. Increased calories require more "B" vitamins for proper utilization.

What the Vitamins Do

Thiamine is the vitamin which helps to build and maintain physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Niacin, which is another of the "B" vitamins, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

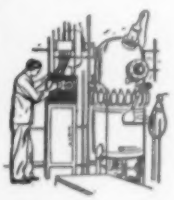
Riboflavin is the vitamin which is essential for growth. It helps to keep body tissues healthy and to maintain proper function of the eyes.

Vitamin D is important to prevent rickets in children and the development of certain abnormal bone conditions in adults.

Iron is essential for making good red blood and for preventing nutritional anemia.

Where Do The Vitamins Come From?

At about the same time that processing losses in breakfast cereals became known, other developments in the science of nutrition produced ample supplies of vitamins at economical prices. Thus, the quality of breakfast cereal foods could be, and was, greatly improved through restoration.



Since the early days of breakfast food restoration and of white flour and white bread enrichment, the world-famous firm of Hoffmann-La Roche has supplied top quality vitamins by the tons. Pioneering work in its laboratories and by its collaborators resulted in the "duplication" of some of Nature's extremely complex substances. First, the chemical composition of the vitamin was learned. Second, the pure substance was isolated. Third, the "duplicate" was made by synthesis. And fourth, the laboratory techniques were extended to large scale operations.

The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

Reprints of this article, and of all others in this series, are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

Affairs of the Institute

Regional News	Recently Elected Members of IFT
Personnel	Annual Meeting Bulletin Board
Selected Abstracts	Food Industry Topics
Books	Future Dates for Food Technologists

Regional Section News

SOUTHERN CALIFORNIA SECTION

Th. R. Knudsen presented Certificate of Achievement as Outstanding Local Food Industrialist.

At its first fall meeting the Southern California Section, Institute of Food Technologists presented to Mr. Th. R. Knudsen, founder and president of the Knudsen Creamery Co. of California, a Certificate of Achievement in recognition of his outstanding leadership in the development of a local food enterprise. The award was the first of its kind to be presented by the Society. The inscription on the Certificate reads:

> "Southern California Section, Institute of Food Technologists, presents this Certificate of Achievement to Th. R. Knudsen, founder and president of the Knudsen Creamery Co. of California, in recognition of his leadership in the development of a Basic Food Industry in Southern California, and for his appreciation of the importance of science and technology in the successful production, processing and distribution of food of superior quality."

The award was presented to Mr. Knudsen (left) by Dr. Max S. Dunn (far right) Chairman of the Southern California Section, Institute of Food Technologists. Dr. Dunn is professor of chemistry at U. C. L. A. Mr. Knudsen was introduced to the Section by Dr. Milton E. Powell (center), Director of Research of the Knudsen Creamery Co. Dr. Powell is the immediate past chairman of the Section. Mr. Knudsen spoke on the development of dairying in Southern California and the part which the Knudsen Creamery Co. has played in the growth of this basic industry. A similar recognition will be made annually to other food industrialists of Southern California.

(Continued on page 4)

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REGIONAL SECTION NEWS

(Continued from page 3)

NEW YORK SECTION

Technologists Must Study Methods, Dr. Burton Tells New York Section

It is not enough for a food technologist to know what is done to a food in processing it. He also must know how it is done—if he wants to earn a salary well into the five-figure class.

That was the significant keynote of a pointed and inspiring talk on unit operations in food engineering made by Dr. Laurence V. Burton at the November 17 meeting of the New York Section of the Institute of Food Technologists. Dr. Burton is executive director of Packaging Institute and former editor of *Food Industries*.

And the hope is that someday all food factories will be managed by food technologists or engineers, Dr. Burton said.

Defining the different technical food functions, the speaker observed that science arises from laboratory investigations, engineering applies that knowledge to factory operations, and in between is the technologist who uses food science to develop processes.

But the engineer makes the processes work to produce products of desired quality at a profitable manufacturing cost. And the engineer was further defined as a man who can do for $1 what any "fool" can do for $3.

Dr. Burton also strongly emphasized that the methods used in processing one type of food product are not basically different from those employed for an entirely different type of food. In fact, there are only 10 or 15 methods that can be used in food plants. These are the basic, or unit, operations and processes such as separating, disintegrating, mixing, heat transfer, forming, packaging, materials handling, fermenting, hydrolyzing, and coagulating.

And technologists should study closely the machines employed in food processing because of their possible effects on the product. An example is the low-temperature vacuum concentrator for heat-sensitive orange juice. By studying machines and methods, technologists can find ways to produce the same result at lower cost.

Filtration was cited as an example of a basic unit operation. The job of a filter is to separate solids from liquids, and it makes little difference to the filter what it is handling. From the engineering viewpoint, the problem is one of doing an effective job, at the right capacity, for the right cost, and with a minimum of maintenance and cleanup work.

Dr. Burton also took food plant operators to task for waiting until some equipment manufacturer comes along with a better method. They, themselves, should take the initiative in developing better methods and equipment. They should tell the equipment manufacturer what they want.

Then the speaker criticized food plant people for being interested only in something directly pertaining to their operation and product. He cited the case of a pie baker who would not read articles on better food processing methods and equipment unless they were strictly for the "pie foundry." Yet this baker needed such basic improvements as a more machinable corrosion-resistant metal and a more durable metal coating for pie tins. And when this was pointed out to him, he saw the mistake he was making in being interested only in that which bore a "pie baking" label.

To emphasize the importance of knowing methods and machines, the speaker pointed out that top management jobs often go to men brought into the food industry from the outside. The reason: Because these men know methods of doing things efficiently.

The way to make savings which will lower product price and build sales is through better methods, not cheapening the formula, Dr. Burton said. If the formula is cheapened, selling costs increase and total costs remain high.

The Hershey bar was cited as an example of a food product which built a great market through high quality at a low price—without the aid of advertising. Very efficient manufacturing methods and equipment made this possible.

The tendency for food plant operators to overlook high packaging costs also was stressed.

In the discussion period following the talk, food technologists in the audience expressed nothing but enthusiastic agreement with the points made by the speaker.

NORTHERN CALIFORNIA SECTION

The Section held a Social Hour and Dinner Meeting on October 29 at the Showboat Restaurant in Oakland, Calif. Daniel F. Gerber was the guest speaker and his topic, "Management and the Future of the Baby Food Industry," was highly interesting. Mr. Gerber is President and Chairman of the Board, Gerber Products Company, and President, Gerber-Ogilvie Baby Foods Ltd., Niagara Falls, Canada. He is also Vice-President and Director, Green Giant Company of Canada.

OREGON SECTION

On October 8, 1954 at 2:00 P.M. the Oregon Section held a meeting at the cannery of Libby, McNeill and Libby, 3500 S. E. 22nd Ave., Portland, Oregon; 29 members and friends attended the meeting. After a conducted tour of the plant, refreshments were served and a short business meeting was held during which the new officers were introduced. Mr. W. D. Mohney, Plant Superintendent, talked about pear canning and pickle manufacturing and led a discussion concerning cannery operation.

WESTERN NEW YORK STATE SECTION

The Niagara Frontier Division of the Western New York State Section, IFT, held its November dinner meeting on November 15 at the Erie County Institute of Applied Arts & Sciences, Buffalo, N. Y. Guest speaker for this occasion was Dr. Norman W. Bartz, Chief of the Bureau of Milk, Food and Restaurant Sanitation of Erie County. The local section of the American Associa-

(Continued on page 6)

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To keep the millions of snapshooters snapshooting, we got involved in such by-paths of research as how to pack film to withstand the tropics. The scientist working on that question wanted to pump air out better than it had ever been pumped out before, so he invented some new vacuum pumps. Then, sort of forgetting why he had started, he looked around for interesting things to do in a super-vacuum. It didn't take long (only nine years or so) to figure out how to put oily materials in such a vacuum, heat them in a thin film, and condense the vapor on a near-by cooler surface. This resulted in sorting out the constituents of the oil, molecule by molecule. After a while, we learned how to do it by the tank car in equipment that bore no resemblance to laboratory glassware.

One of the things we tried in the molecular stills was the mono-diglyceride emulsifier that had come into the fat business in the early '30s. We found that the process separated out the active mono from the inactive esters, the free glycerine, the catalyst, the taste, and the color. It concentrated the "shortening improving" effect in the distillate. We marketed the distillate under the trade-mark "Myverol."

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REGIONAL SECTION NEWS

(Continued from page 4)

tion of Cereal Chemists was also invited to attend this meeting.

NORTHEAST SECTION

The first meeting of the 1954-55 season of the Northeast Section was held at the Faculty Club of the Massachusetts Institute of Technology with an attendance of almost 100 people. The speaker of the evening was none other than our well-liked and very capable editor of the IFT journals, Dr. Martin S. Peterson, who presented a fascinating as well as significant talk entitled "Editorially Speaking." The intense interest in the journals was evidenced by the large number of questions at the end of the discussion. Mrs. Peterson, who assists in the editorial function, was also present and was introduced to the group.

"Students Night" was held on November 4th, and a special program was arranged for the students of the Departments of Food Technology of the Massachusetts Institute of Technology and of the University of Massachusetts. A total gathering of 143 dinner guests was present to hear Dr. William R. Van Meter, Director of Research of the Heublein Company of Hartford, Connecticut, discuss "Things My Teacher Never Taught Me." Through the generosity of the following New England firms, complimentary dinners were presented to the student members:

First National Stores
The Great Atlantic & Pacific Tea Company
Herlihy Brothers
The New England Confectionery Company
Revere Sugar Company
Friend Brothers, Inc.
William Underwood Company
Colonial Provision Company
J. O. Whitten Company
Gorton-Pew Fish Company
A. D. Little, Inc.
Seaplant Chemical Company
Artisan Metals Company
Stickney and Poor Spice Company
Dewey and Almy Chemical Company

The very fine programs arranged for this year, a result of the efforts of chairman Dr. Jean F. Caul and vice-chairman Dr. Ernest E. Lockhart, have been rewarded by a great increase in attendance.

The December meeting of the Northeast Section is Ladies' Night, and for this program, a speaker has been selected who should prove interesting to all. Her name is Mrs. Heloise Broeg, "Mother Parker," and she is in charge of Home Economics for the Columbia Broadcasting System office in Boston.

The officers for the year 1954-55 are:

Dr. Jean F. Caul, Arthur D. Little, Inc., Chairman
Dr. E. E. Lockhart, M.I.T., Vice-Chairman
Dr. Arthur S. Levine, Univ. of Mass., Treasurer
Mr. Lyle Richardson, Foxboro Instrument Co., Secretary

Committee Chairmen for this year are:

Program committee: E. E. Lockhart
Budget committee: A. S. Levine

(Continued on page 8)

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Myvax Vitamin A

Vitamin A
is where you find it

There's a little vitamin A in a lot of places. Sometimes *so* little you aren't sure it's there at all. Or in which of its many forms.

Such is the tale of the "lard factor."

Not so long ago, a new vitamin was announced. Turned up in freshly rendered lard. It was called the "lard factor." A little later, the people who found it decided it had the biological activity of vitamin A but differed from any known form.

This news had the usual trigger reaction, and other vitamin researchers joined in. One group, working with a lard distillate, found approximately 10 units of vitamin A activity per gram, didn't know what form it took, confirmed the existence of the "lard factor." Another worker found no indication of the "lard factor."

The circle came around again when members of the original team took another whack at the problem and found ordinary vitamin A in small amounts. The existence of the "lard factor," they concluded, was unlikely, but not completely excluded.

Naturally enough, we were interested in all this. We joined in and found that the so-called "lard factor" in molecular distillates of lard is in fact, plain, old, everyday vitamin A.

So it goes. Not all vitamin A research is so unrewarding. And there is no way of knowing in advance when the pursuit of learning will turn up new knowledge. For us, it's all a part of being a leading supplier of vitamin A, a role we've cherished for years. We make Myvax Vitamin A Palmitate and Acetate in bulk, Myvapack Vitamin A in batch-size premeasured cans. And we can ship from stock. For information or a quotation, write ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies and Company, Los Angeles and San Francisco • Charles Albert Smith Limited, Montreal and Toronto.

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REGIONAL SECTION NEWS

(Continued from page 6)

Auditing committee: L. Shipmen
Publicity committee: S. A. Goldblith
Employment committee: Ozro Fish
Membership committee: W. L. Cummings
Hospitality committee: C. Widegren
Section counselors: L. B. Sjöstrom, S. A. Goldblith.

OHIO VALLEY SECTION

The Ohio Valley Section met with the Great Lakes Section on Saturday, October 30, at the University of Toledo. A good representation from each group was in attendance.

Dr. Pauline Paul, chairman of the Great Lakes Section, presided at the forenoon meeting and introduced three speakers from the host section. Their topics were as follows:

"Sanitation Practices in Baby Food Manufacture." Hal Delo, Gerber Products Company, Fremont, Michigan

"Interpretations of Shrimp and Fish Technology." Karl Envoldsen, Envoldsen Shrimp Company, Cleveland, Ohio

"Hydrolyzed Vegetable Proteins — Their Manufacture, Characteristics and Uses." L. J. Minor, L. J. Minor Company, Cleveland, Ohio

A delicious luncheon was served at noon in the University of Toledo cafeteria and members of the two sections had an opportunity to become acquainted. Brief business meetings were held by the sections separately.

The afternoon program was presented by the Ohio Valley Section members and the vice chairman, Dr. F. E. Deatherage, presided. The subjects presented were these:

"Food Plant Waste Disposal." Dr. H. D. Brown, Department of Horticulture, The Ohio State University, Columbus, Ohio

"Flexible Packaging of Food." Florren Long, Shellmar-Betner Division, Continental Can Company, Mt. Vernon, Ohio

"Margarine and Shortenings: What Have You?" Dr. J. B. Brown, Department of Physiological Chemistry, The Ohio State University, Columbus, Ohio

Mutual benefit from the sharing of ideas and getting acquainted with one's neighbors was a worthwhile outcome of this joint meeting.

MARYLAND SECTION

Due to the competition from Hurricane Hazel which blew through Baltimore about the same time that the October meeting was scheduled for, the attendance was rather limited. The meeting was held at the Stafford Hotel, Baltimore, on Friday, October 15, and those present enjoyed a most informative talk on the subject of "Use of Antioxidants in Foods" by Dr. H. R. Kraybill of the American Meat Institute Foundation.

Thirty-five members and guests attended the November Meeting of the Maryland Section which was held at Rice's Bakery, Baltimore, on Friday, November 12.

The meeting began with a plant tour which covered the manufacturing of bread, rolls and pastries. Dinner was served in the plant cafeteria, and after dinner, the group was shown an interesting motion picture through the courtesy of Standard Brands, Inc. The title of the movie was "Land of Everyday Miracles" and among other things was concerned with the baking industry.

After the movie Joseph Babeor, Production Manager for Rice's Bakery, addressed the group on the subject of "Quality Control of Bakery Products." He stressed the fact that the most important phase of quality control in the baking business was service to the customer. Making sure that the products sold are the products which she wants is the never-ending task of the quality baker.

Mr. Babeor pointed out that Rice does not distribute to stores and in effect wholesale their bakery products, but rather they deliver their merchandise direct to the consumer by means of door-to-door deliverymen and their own bake shops. He said that in any given week they sold 120 different bakery items, but that 60% of their sales dollar was for white bread.

He then traced the process for manufacturing a loaf of bread and described the various controls that are exercised at the critical points in the process.

A lively question-and-answer period followed his formal presentation.

GREAT LAKES SECTION

The Great Lakes Section of the Institute of Food Technologists met jointly with the Ohio Valley Section at the University of Toledo, Toledo, Ohio, October 31, 1954.

The first speaker was Haldon L. Delo who gave a very interesting talk on "Sanitation Practices in Baby Food Manufacture," as practiced at Gerber Products Company. After mentioning the fact that sanitation is not much good without 100% management cooperation, and that sanitation had that at Gerber's, he detailed their method for the group. He ended by saying that their procedure was in book form so that everyone requiring the information could have it, and, therefore, it was not dependent on any one person or department.

The second speaker was Karl Envoldsen of Envoldsen Shrimp Company who talked on "Interpretations of Shrimp and Fish Technology." He gave many there much to think about. A technologist should not only be trained to find trouble, but must be versatile enough to find causes and get employers out of these troubles, or even be able to foresee impending trouble and ward it off.

The third speaker was L. J. Minor who spoke on "Hydrolyzed Vegetable Proteins." He spoke of needed building materials, floors, equipment and sanitation and then went into details about the chemistry of his products. He gave free samples to everyone present and discussed these at length.

Luncheon was served in the University cafeteria, where the Board of Directors, seated at one table, had their meeting. After lunch and before the afternoon session the corporate meeting of the Section met for annual business. The Treasurer reported a balance on hand of $2,684.73. The results of the election were

(Continued on page 10)

Announcing

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10% BHA **6% Propyl Gallate**
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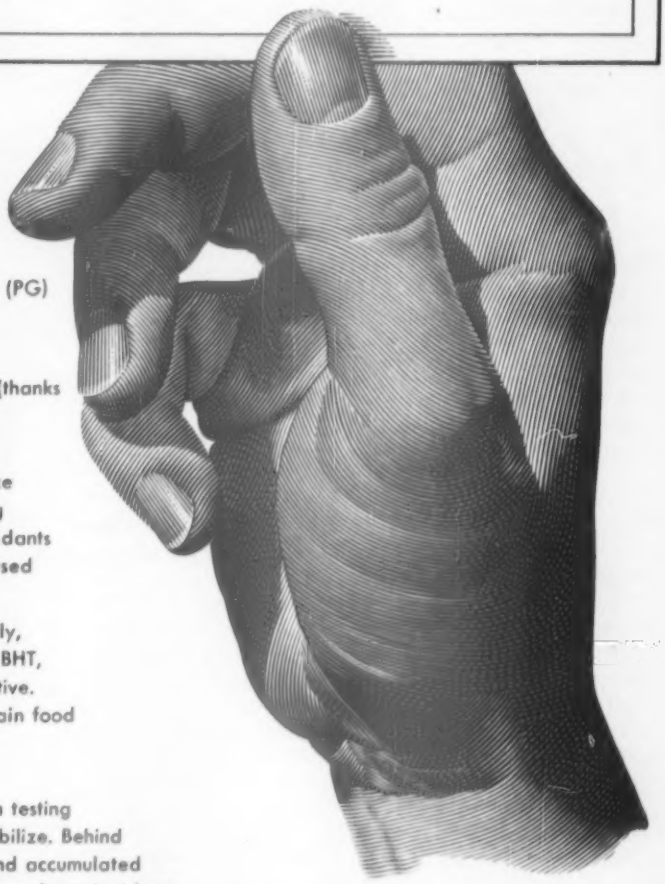
dissolved in propylene glycol and mixed glycerides of corn oil



Tenox VI is the newest addition to the Tenox series of food-grade antioxidants.

Tests carried out in Eastman's Food Laboratories indicate that for many food products Tenox VI is the best readily fat-soluble combination of butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and propyl gallate (PG) available.

By offering BHT, BHA and PG in a single solution, Tenox VI brings to the user both high AOM values (thanks to PG) and high carrythrough stability (due to the synergistic behavior of the BHT-BHA combination).

In addition, this combination enables the user to take full advantage of the USDA's regulations permitting up to 0.02% antioxidant when two or more antioxidants are used, whereas any single antioxidant may be used only up to a maximum of 0.01%.

Is Tenox VI the right antioxidant for you? Frankly, we cannot give a blanket answer. The efficiency of BHT, BHA and PG (used alone or in combination) is selective. The decision to use a specific antioxidant for a certain food always must be based on careful testing of the individual food product involved.

Eastman will be glad to advise or even undertake a testing program for whatever food product you wish to stabilize. Behind our recommendations will be years of experience and accumulated data unmatched by any other manufacturer of food-grade antioxidants.

If you would like to explore the suitability of Tenox VI— or any other Eastman antioxidant—for stabilizing your product, write to Eastman Chemical Products, Inc., a subsidiary of Eastman Kodak Company, Kingsport, Tennessee.

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REGIONAL SECTION NEWS

(Continued from page 8)

read, showing the following had been elected: Vice Chairman, George L. Alexander; Secretary, Wm. F. Robertson; Treasurer, Edna Mae McIntosh; and two new members to the Executive Committee—R. N. Costilow and M. R. Dietz.

First speaker of the afternoon session was Dr. H. B. Brown of the Horticulture Department, Chio State University, who talked on "Food Plant Waste Disposal." His talk was very interesting, bringing out some of the difficulties encountered in such a project. His talk was augmented by photographs which he had taken at various waste disposal plants in various sections of the country.

The next speaker was Florren Long, Shellmar-Betner Division, Continental Can Company. His subject was "Flexible Packaging of Foods," and he covered the subject very well. Moisture-vapor equivalent, relative vapor constant, gas transmission, shelf life, temperature of fill and storage, light, grease proofness, size, style, flexible wear, seal, etc., were but a few of the topics covered. He had a good supply of samples to show.

The last speaker of the day was Dr. J. B. Brown, Physiological Chemist, Ohio State University, who talked about "Margarines and Shortenings." After some figures showing the trend away from butter and lard and into margarines, he went into the chemistry of hydrogenation, bringing out the presence of trans-fatty acid in incompletely hydrogenated fats, showing that we did not know what we were eating. His talk was very enlightening.

PITTSBURGH SECTION

The Pittsburgh Section held its first dinner meeting of the 1954-55 season on Tuesday, October 12, at the Royal York Dining Room. Philip C. Althen, Head of the Packaging Section, Sales Division of the Aluminum Company of America spoke on "Aluminum Foil—Its Role in Flexible Packaging." Following his talk there was a question and answer session, accompanied by demonstrations of new and different uses for aluminum foil in packaging.

Vice-Chairman Charles J. Steinicke announced that Dr. Charles Glenn King, Scientific Director, Nutrition Foundation Inc. will be speaker at the December 14 meeting. Mr. Steinicke also reported that Dr. L. E. Clifcorn of Continental Can, Mr. A. V. Grundy of QM Food and Container Institute for the Armed Forces and Dr. Carlos A. Greenleaf of National Canners Association had all accepted the invitation of the section to speak at future dates.

PHILADELPHIA SECTION

The Philadelphia Section met November 9, 1954 at Drexel Institute of Technology. Mr. John Sampey gave the report of the Auditing Committee. Mr. Mahle, the Vice Chairman, announced the program for the December meeting, which will be the annual Ladies' Night. Mr. A. A. Schaal, Director of the Good Housekeeping Bureau will be the speaker.

Dr. G. P. Whitlock of Merck and Company addressed the Section. The talk was entitled "Figures—Facts or Fancy." With the aid of some interesting illustrated figures, Dr. Whitlock demonstrated with numerous examples how the science of statistics may serve to facilitate and enhance the value of research and quality control, with special reference to its application to the Food Industry. He stressed the importance of utilizing the advice of statistical experts in the planning of experimental work. He also pointed out that carelessness in the application of statistical analysis causes many pitfalls and that, on the other hand, statistical manipulation may be utilized by biased persons to produce almost any conclusion that they may wish to obtain.

A Food Sub-committee of the Chemical Section of the American Society of Quality Control is being organized in this vicinity to spread knowledge of statistical techniques in the Food Industry. Anyone interested please write to Mr. E. P. Webster, Brock & Company, 420 E. Erie Avenue, Philadelphia, Penna.

PERSONNEL

Dr. Warren Stone, formerly with the Quartermaster Food and Container Institute for the Armed Forces, has accepted a position on the staff of Virginia Polytechnic Institute where he will conduct research on dairy industry problems with special attention to dry whole milk problems.

Dr. Pauline Paul, Department of Foods and Nutrition, School of Home Economics, Michigan State College, has accepted a position on the Home Economics faculty of the University of California at Davis.

Selected Abstracts*

ANALYTICAL METHODS

Detection of heliotropin in mixtures of vanillin and heliotropin.

Castiglioni, A., and Bionda, G. *Z. anal. Chem., 141,* 189-90 (1954); *J. Sci. Food Agr., 5,* 50, July, 1954.

Heliotropin can be detected in the presence of vanillin on the micro scale by the formation of an insol. condensation product with cyclohexanone in aq. alc. soln., the ppt. washed with H_2O and the filter dried. On the addn. of a drop of H_2SO_4, the deep violet color of 2:6-dipiperylidenecyclohexanone confirms the presence of heliotropin. Coumarin, salicylic acid, acetyl-salicylic acid, and benzoic acid do not interfere.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

The deproteinization of nucleoproteins.

Jones, A. S., and Marsh, G. E. *Biochim. et Biophys. Acta, 14,* 559-66 (1954).

Various methods for the deproteinization of the nucleoproteins of *Myco. phlei, Aerobacter aerogenes* and thymus were studied in detail. The deproteinizing agents investigated were strong salt solns., $CHCl_3$ and octanol, sodium dodecyl sulfate (S. D. S.) and chloral hydrate. The best method found was to remove the bulk of the protein by the use of S. D. S. or chloral hydrate and the remainder by 1 or 2 treatments with $CHCl_3$ and octanol.

* These Selected Abstracts are made available to Food Technology through the cooperation of Associate Editor H. A. Campbell and the General Foods Corporation of New York, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.

(Continued on page 12)

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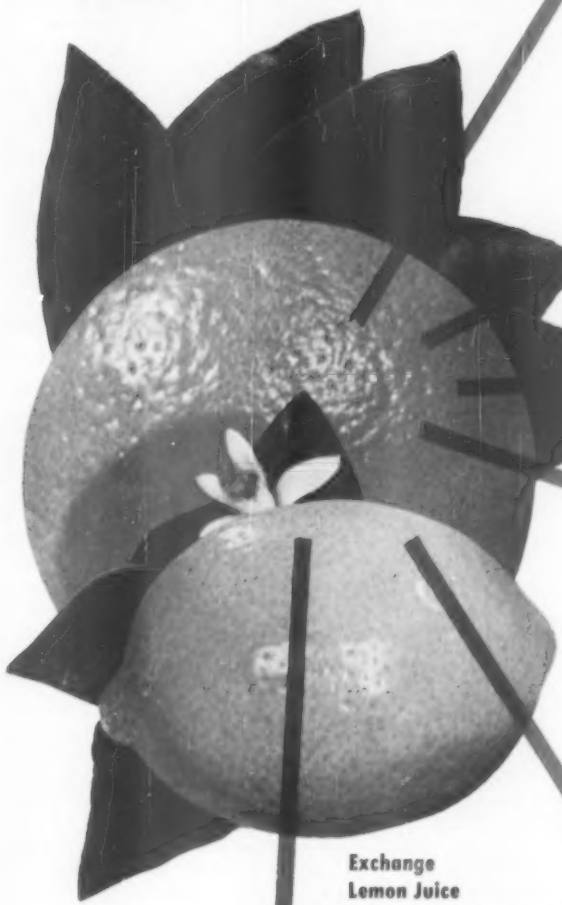

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SELECTED ABSTRACTS

(Continued from page 10)

Application of rhodamine-B to interaction studies in proteins and simple model systems.

LUNDGREN, H. P., AND BINKLEY, C. H. *J. Polymer Sci., 14,* 139-58 (1954).

With rhodamine-B used as an indicator, the relative acidities of selected phenols and alcs. as model H donors were detd. in toluene soln. The method has been applied to the detn. of equil. consts. for the interaction of phenol with dimethyl formamide, benzyl acetate and dioxane. The dye is useful also for the detn. of crit. micellar concn. of fatty acid soaps in aq. soln. It also shows markedly increased binding by heat-denatured as compared with native egg albumin, and by acetylated, as compared with normal, wool.

MICROBIOLOGY

A strain of Shigella dysenteriae 1 requiring proline.

JOHNSON, R. B., AND MAYS, C. G. *J. Bacteriol., 67,* 542-4 (1954).

A proline requiring variant of *S. dysenteriae* 1 is described along with a basic medium which allows for the microbiol. assay of L(-)-proline. Good specificity is exhibited; D-proline and D- or L-hydroxyproline being unable to replace L-proline.

The use of metabolites in the restoration of the viability of heat and chemically inactivated Escherichia coli.

HEINMETS, F., TAYLOR, W. W., AND LEHMAN, J. J. *J. Bacteriol., 67,* 5-11 (1954).

Expts. indicate that suspensions of *E. coli,* strain B/r, which were sterilized by the action of heat, chlorine, "zephiran" chloride, and ethyl alc. contain viable cells when incubated with various metabolites of the tricarboxylic acid cycle. When such "sterile" suspensions are incubated in buffer or in nutrient broth, no viable cells can be demonstrated.

A simple electrical recorder of the bacterial colonies enumerated in viable counts.

INGRAM, M., AND PAGE, L. J. *Lab. Practice, 3,* 385-6 (1954).

The app. can be used to enumerate colonies as they are touched on the surface of agar, as in the Miles and Misra technic. It is cheap and assembly can be done by an electrical technician in a day.

Exposures of microorganisms to measured sound fields.

KINSLOE, H., ACKERMAN, E., AND REID, J. J. *J. Bacteriol., 68,* 373-80 (1954).

No significant effect due to varying pH from 4.0-7.0 or temp. from 15-45° C. was observed on the breakdown rate of *Escherichia coli* and *Serratia marcescens* exposed to the sound field of the Raytheon magnetostriction oscillator.

Bacteria protect skin.

Soap Chem. Specialties, 30, 107, September, 1954.

The bacteriostatic defenses of the human skin consist of its resident bacterial flora and not of its acid mantle, according to Koechel, Deutsche Apothekerzeitung, 1952, 30, 542. In an expt. penicillin-resistant staphylococci were placed on hands which had previously been treated with penicillin and on untreated hands. After several hrs. the staphylococci were undetectable on the untreated hands, whereas they were demonstrable in masses on the penicillin treated skin. The penicillin did not affect the acid layer of the skin, but it did destroy the normal bacterial flora.

NUTRITION

Role of antibiotics in the nutrition of the rat and certain bacteria.

PETERSON, G. E. *Dissertation Abstr., 14,* 1128-9 (1954).

Expts. in feeding rats diets deficient in B_{12} but supplemented with dextrin and an antibiotic seem to indicate that the growth stimulating properties of such diets may be the result of their effect on intestinal microflora. In addn., the development of drug fast intestinal flora may be the result of changes in the physiology of the organism which may in turn affect the nutritional well being of the host.

The use of carcass analysis in estimation of amino acid requirements.

Nutrition Revs., 12, 278-80 (1954).

These expts. indicate that the carcass analysis method is in general a good method for estg. amino acid requirements. One objection is that no distinction is made between the pattern of amino acids required for various functions such as growth, pregnancy, lactation, etc. When the exact amino acid requirements for all the various functions are known one should be able to assess accurately the biologic value of proteins by the relatively simple and inexpensive procedure of detn. of their amino acid compn.

Fat emulsions as caloric supplements in parenteral nutrition, with particular reference to amino acid utilization.

CANNON, P. R., FRAZIER, L. E., AND HUGHES, R. H. *J. Lab. Clin. Med., 44,* 250-60 (1954).

The parenteral administration of supplemental cals. in the form of fat emulsions effected a rapid conversion of protein hydrolyzate into tissue protein, as evidenced by wt. gains and by increases in body H_2O and body protein. Rats not receiving fat emulsions were able to maintain wt. for 8 days while receiving protein hydrolyzate; they then lost wt. rapidly commencing at the time when they had lost approx. 70% of their body fat. The expts. demonstrate the dynamic nature of the fat reserves and the capacity of these reserves to contribute cals. to the metabolic pool for a considerable period of time.

Beneficial effect of low-fat diets on the swimming performance of rats and mice in cold water.

ERSHOFF, B. H. *J. Nutrition, 53,* 439-49 (1954).

The swimming performance of rats and mice at a H_2O temp. of 20° C. was inversely proportional to the fat content of the diet. Animals fed purified fat-free diets or similar diets supplemented with 1% cottonseed oil or 1% hydrogenated coconut oil swam significantly longer than animals fed similar rations supplemented with 10% cottonseed oil or 10% hydrogenated coconut oil. When swimming tests were conducted at a H_2O temp. of 37° C., no significant difference in swimming performance occurred between the various dietary groups.

Nutrient intake and blood findings of men on a diet devoid of meat.

MIRONE, L. *Am. J. Clin. Nutrition, 2,* 246-51 (1954).

Prolonged consumption of a diet low in animal protein had no apparent deleterious effect on the health of members of a community which did not eat meat.

Effect of "tween-65" and "tween-80" on gastrointestinal motility in man.

JANOWITZ, H. D., HOLLANDER, F., AND MARSHAK, R. H. *Gastroenterology, 24,* 510-16 (1953); *Brit. Abstr. Med. Sci. 692* (1954).

No subjective reactions or changes in bowel habit, character of stools, and body wt. were induced by either of these substances. No evidence was obtained to indicate that intestinal transit time, measured either as mouth-to-rectum time by carmine marker, or stomach-to-colon time by Ba, was affected significantly.

Progressive muscular dystrophy in rabbits as a result of chronic choline deficiency.

HOVE, E. L., AND COPELAND, D. H. *J. Nutrition, 53,* 391-405 (1954).

Creatine excretion gradually increased to more than 40 mg./kg./day, while the creatinine excretion decreased to less than 2/3 of the normal value. The posterior extremities became flaccid and extremely weak, although complete loss of muscle control did not occur. Histologic studies on the muscle have shown hyaline degeneration and other lesions characteristic of muscular dystrophy. The addn. of choline to the diet brought about a rapid cure of the clinical dystrophy and creatinurea within 3 days.

(Continued on page 14)

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SELECTED ABSTRACTS

(Continued from page 12)

Diet and plasma cholesterol levels.

MAYER, G. A., CONNELL, W. F., DEWOLFE, M. S., AND BEVERIDGE, J. M. R. *Am. J. Clin. Nutrition, 2,* 316-22 (1954).

The results of this investigation indicate that, within the limits used here, dietary cholesterol has no effect on plasma cholesterol levels, whereas alterations in the level of dietary fat, whether or animal or vegetable origin, led to parallel changes in plasma cholesterol.

The relation of diet to atherosclerosis.

Nutrition Revs., 12, 270-1 (1954).

Fat *ver.* cholesterol content of the diet are discussed as causative factors.

Effect of some steroid compounds on ovine rumen function.

BROOKS, C. C., GARNER, G. B., MUHRER, M. E., AND PFANDER, W. H. *Science, 120,* 455-6 (1954).

Stilbestrol at a level of 10 or 20 p.p.m. increased cellulose digestion by ovine rumen microorganisms *in vitro* and *in vivo* but could not be tolerated by sheep at these high levels. Cholesterol and estrone increased cellulose digestion by rumen microorganisms *in vitro.*

Does a low intake of calcium retard growth or conduce to stuntedness?

WALKER, A. R. P. *Am. J. Clin. Nutrition, 2,* 265-71 (1954).

The conclusion is reached that it has not been established that Ca intake *per se* is of importance in regulating height. It is suggested that apart from gross undernutrition, that crit. intake of Ca below which retardation of growth occurs, lies below the wide range of Ca contents of everyday diets consumed in different parts of the world.

Nutrition and human growth.

Nutrition Revs., 12, 271-4 (1954).

The material presented in this review adds some important new data, but it does not provide conclusive quant. evidence on the effect of diet in man's physical development and his final body dimensions.

Some thoughts regarding obesity.

KINSELL, L. W. *Am. J. Clin. Nutrition, 2,* 350-2 (1954).

A cal. is not necessarily a cal. insofar as wt. reduction is concerned; i.e., the qual. make-up of a diet, as well as its caloric equivalence, may influence in a major way the pattern of wt. change.

PHARMACOLOGY AND TOXICOLOGY

Threshold limit values for 1954.

Arch. Ind. Hyg. Occupational Med., 9, 530-4 (1954).

Values are given for the max. av. atm. concn. of contaminants to which workers may be exposed for an 8 hr. working day without injury to health.

Toxicity of vanillin, o-vanillin, and ethylvanillin and of the corresponding meta aldehydes.

CAUJOLLE, F., AND MEYNIER, D. *Ann. pharm. franc., 12,* 42-9 (1954); *Chem. Abstr., 48,* 8948d (1954).

Introduction of a 2nd aldehyde group in the meta position to the first in vanillin (I) and ethylvanillin (II) increases the toxicity and imparts convulsant properties; o-I is markedly more toxic than I and is a potent convulsant. The introduction of a 2nd aldehyde group in the meta position increases the toxicity and modifies the convulsive properties. The LD_{50} in the mouse is (in g./kg.) for I 0.78, o-I 0.4, I dialdehyde 0.15, II 0.75, and II dialdehyde 0.14.

PHYSIOLOGY AND MEDICINE

Liver changes in vitamin B_{12} and riboflavin-deficient rats before and after partial hepatectomy.

SCHWEIGERT, B. S., SCHEID, H. E., AND DOWNING, M. *Am. J. Physiol., 178,* 338-9 (1954).

The author claims that these studies provide further evidence for the specific role of vitamin B_{12} in nucleic acid synthesis.

The structure of the hereditary material.

CRICK, F. H. C. *Sci. American, 191,* 54-61, October, 1954.

A discussion of how recent studies of desoxyribonucleic acid have yielded clues which may solve the secret of how cells and all living things reproduce themselves in their own image.

The use of citrus flavonoids in respiratory infections.

BISKIND, M. S., AND MARTIN, W. C. *Am. J. Digest. Diseases, 21,* 177 (1954).

ENGINEERING AND PLANT EQUIPMENT

Elements of dust and mist collection.

LAPPLE, C. E. *Chem. Eng. Progr., 50,* 283-7 (1954).

This paper summarizes from the viewpoint of the plant or design engineer, (1) the known types of collection equipment, (2) the type, procurement, and utilization of information necessary for proper selection and design of dust and mist-collection equipment, and (3) references that may be consulted for specific details.

Pumps.

HICKS, T. *Power, 98,* 75-106, October, 1954.

A complete discussion of pumps is presented including applications and methods for selection.

Ion exchange.

HIESTER, N. K., AND PHILLIPS, R. C. *Chem. Eng., 61,* 161-80, October, 1954.

A comprehensive review. 56 references.

Educational engineering programs at G. E.

WARZECHA, L. W. *Gen. Elec. Rev., 57,* 28-31, September, 1954.

Feeling a need to supplement the "book knowledge" of the newly graduated engineer, General Electric has developed the program of advanced training briefly described in this article.

FOOD AND FOOD TECHNOLOGY

CEREALS AND GRAINS

Rice substitutes.

SUBRAHMANYAN, V., BHATIA, D. S., SWAMINATHAN, M., AND BAINS, G. S. *Nature, 174,* 199-201 (1954).

A review of types offered thus far with a table of chem. compn. for 6 types.

Color soybean lecithin in relation to processing conditions.

DUTTON, H. J. *Soybean Digest, 14,* 27, August, 1954.

The brown color is very likely an aldehyde amine reaction product. It is largely formed by heating of the oil during the solvent-stripping operation. It is not increased by drying the gums under vacuum for 3 hrs. at 80° C., but it is increased on heating at 100° C. under the same conditions. The formation of the brown color is not prevented by removal of free sugars or by hydrogenation of the lecithin.

The lipids in flour. Oxidative changes induced by storage and improver treatment.

MORAN, T., PACE, J., AND MCDERMOTT, E. E. *Nature, 174,* 449-52 (1954).

The oxidative changes of the lipids in flour induced by storage and improver treatment were studied. Included were: the stability of the fat-sol., biologically active forms of the tocopherols and the degree of oxidation of the unsatd. fatty acid.

(Continued on page 16)

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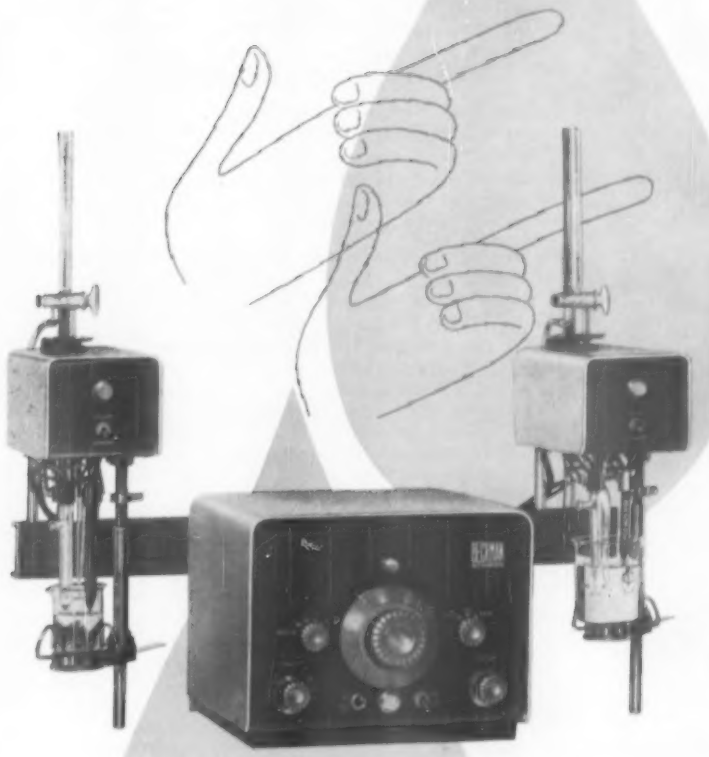

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SELECTED ABSTRACTS

(Continued from page 14)

The flavor of porridge.

MORAN, T., HUTCHINSON, J. B., AND THOMLINSON, J. *Nature, 174,* 458 (1954).

The nutty oatmeal flavor of porridge is compared to the flavor of bread. The conditions necessary to obtain this flavor with oatmeal are outlined. These conditions, however, were unsuccessful with wheat.

CHEMICALS IN FOODS

Viewpoints on the problems of chemicals in foods.

Am. J. Public Health, 44, 977-93 (1954).

Titles include: Some new questions relating to chemicals in foods, F. C. Bing. Laboratory problems in establishing the safety of food additives, B. L. Oser. The nutritional point of view: what is expected of foods? W. J. Darby. The viewpoint of a food manufacturer, R. C. Newton. The view of the food and drug administration: regulation of food additives, C. A. Herrmann. Chemicals in foods: a legal viewpoint, V. A. Kleinfeld.

COCOA

Cocoa fermentation.

WADSWORTH, R. V., AND HOWAT, G. R. *Nature, 172,* 392-4 (1954).

A fermentation technic is described which is very useful for small scale lab. test runs. Beans, killed by cold and then fermented using pure cultures of organisms, or prepd. by the aseptic method, do not produce anything resembling a chocolate flavor. In certain expts. an atm. of CO_2 was maintained around the beans held at 50° C. during drying, again producing a poor chocolate flavor.

DEHYDRATED FOODS

Tomato powder processes developed in west by USDA.

J. Agr. Food Chem., 2, 966' (1954).

Three processes are described: a one step vacuum drying process in which the juice is concd. and dried directly; a split-run vacuum process in which pulp and "tomato serum" are sepd., dried separately, and recombined; and a spray drying technic. The spray drying technic produces a fine powder which is difficult to reconstitute with cold H_2O.

FATS

The relation of synergist to antioxidant in fats.

PRIVETT, O. S., AND QUACKENBUSH, F. W. *J. Am. Oil Chemists' Soc., 31,* 321-3 (1954).

Citric and ascorbic acids, delayed substantially the rate of peroxide accumulation, during the induction period, of lard which contained pro-oxidant levels of α-tocopherol or NDGA. Evidence indicates that ascorbic and citric acid function as synergists in natural fats and oils by inhibiting the antioxidant catalysis of peroxide decompn. This concept is discussed in relation to current theories of the mechanism of synergist action.

MILK AND MILK PRODUCTS

Why coffee sometimes turns grey when adding condensed milk or cream.

MOHR, W., AND MERTEN, D. *Milchwissenschaft, 9,* 106 (1954); *J. Dairy Sci., 37,* No. 775 (1954).

Condensed milk was found to dissolve sufficient Fe from imperfectly tinned cans to cause a grey discoloration in coffee.

Lactose crystallisation in ice cream. I. Control of crystal size by seeding.

NICKERSON, T. A. *J. Dairy Sci., 37,* 1099-105 (1954).

Adequate seeding of ice cream during freezing or of ice cream mix shortly before freezing was found to prevent development of large lactose crystals. The results show large lactose crystals develop during storage of normal ice cream because of the inadequate no. of nuclei to remove the supersatd. lactose as impalpable crystals.

SUGARS

The separation of D-glucose and D-fructose from invert sugar or sucrose.

SMITH, F., AND SPRIESTERSBACH, D. *J. Am. Chem. Soc., 76,* 4191-2 (1954).

A suspension of finely divided sucrose and a cation exchange resin in acetone contg. a small amt. (5%) of H_2O is stirred at room temp. and simultaneous hydrolysis of the sucrose and condensation of the derived fructose with acetone take place with the formation of a clear soln. This stage is reached in about 18 hrs. and soon thereafter cryst. D-glucose begins to sep. Eventually a nearly quant. yield of D-glucose is produced.

ORGANIC CHEMISTRY

Sweetness and configuration in rhamnose.

TSUZUKI, Y., AND MORI, N. *Nature, 174,* 458-9 (1954).

It was found that β-L-rhamnose was sweeter than α-L-rhamnose. This is in agreement with the author's theory that the sweeter form of reducing sugars has cis-hydroxyl groups on the carbonyl and adjacent C atom.

neo Ketose: A trisaccharide formed from sucrose by yeast invertase.

GROSS, D., BLANCHARD, P. H., AND BELL, D. J. *J. Chem. Soc.,* 1727-30 (1954).

The new substance is composed of two D-fructose and one D-glucose radicals. From analysis of the cleavage products of the mixed methylated sugars the following structure has been assigned to the new trisaccharide; *O*-β-D-fructofuranosyl (2→6)-α-D-glucopyranosyl (1→2)β-D-fructofuranoside. It appears to be formed by enzymic transfer of a β-D-fructofuranosyl radical to sucrose. The common name *neo*ketose is suggested. Confirmation is thus provided that invertase will transfer β-D-fructofuranosyl radicals to the primary alc. group of D-glucopyranose as well as to those of D-fructofuranose.

A system of characterization of common organic acids.

WENDLAND, R. T., AND WHEELER, D. H. *Anal. Chem., 26,* 1469-74 (1954).

Acids may be considered as derivs. of many other types of compds. convertible to acids. Org. acids contg. C, H_2, and O_2 only can be divided into 4 well-defined classes based on common phys. properties and simple chem. tests. Identification of the drying oil acids calls for u.v. absorption studies, or chem. processes of bromination, hydroxylation, and isomerization.

PACKAGING

Shock test for plastic films.

MCMILLAN, J. G. *Modern Packaging, 27,* 119-23', August, 1954.

A simple reproducible method of detecting flaws that may cause failure of polyethylene and other bags.

SOAPS

Evaluation of germicidal soaps.

Soap Chem. Specialties, 30, 42-5', August, 1954.

The evaluation method is based on the odor level of a person and his clothing. The method depends on direct sniffing. Objections to the subjectivity of the test can be "removed" by a suitable exptl. design and by the use of fairly simple but standardized organoleptic evaluation procedures. Nos. are assigned to the following odor levels: absent, little, definite, strong, overpowering.

GENERAL INFORMATION

Objectivity comes to food research.

Chem. Eng. News, 32, 3356 (1954).

Monsanto have developed a new instrument to measure fundamental rheological properties. It measures elasticity as a function of resonance frequency and represents an improvement over earlier methods of studying recovery characteristics of dough stretching.

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Books

MICROBIOLOGY OF MEATS, Third Edition. Lloyd B. Jensen. 422 pages, xvi, The Garrard Press, Champaign, Illinois.

This work, like its earlier editions, maintains its status as the definitive work in its field. As its title indicates, it covers all aspects of the microbiology of meats in detail. As its title does not indicate, many phases of the chemistry and technology of meats are also better covered here than in any other compilation. This will come as no revelation to readers of the earlier editions.

In comparison with the earlier editions, it is perhaps discouraging to note that there is less obvious difference between the second and third editions, nine years apart, than between the first and second editions, three years apart. This would seem to suggest that recent work has been more a consolidation of gains than the opening of new territory.

This is not to say that the new edition is a cursory patching job of the last one. The entire book has obviously been critically reviewed, revised, and reorganized. It is difficult to find a section where there has not been some alteration of the earlier textual material as well as addition of newer findings. Apparently to make room for the new material with only 33 added pages, the chapter on poultry has been dropped, along with the author index. Fuller coverage of frozen meats and the problems attendant on prepackaging marks the trends of the times.

As before, the work of the author's colleagues has been drawn on freely, much of it not published elsewhere. Even so, it is disconcerting to note how many of the ideas put forward are empirical without theoretical explanation, vague, or speculative. Much obviously remains to be done, particularly at the fundamental level. The suggestion that the pace is picking up appears from the fact that this new book does not mention the pickle curing of bacon by injection and touches only lightly on the use of phosphates and ascorbic acid. It may not be so many years until the next revision.

In his preface, Dr. Jensen disclaims any pretense of completeness of literature coverage. In any work of this scope, such a disclaimer is almost to be understood. The fact remains, however, that this book is an excellent entry into the literature of meat science and technology. References are given as footnotes close to the point of mention and are not only plentiful but show an impressive breadth of field drawn on.

The chemistry and microbiology of meat are so inextricably intertwined and this book covers both so well that no technical worker in the meat field should be without a copy of this book within easy reach.

VIRGIL O. WODICKA
Chicago, Illinois

ELEMENTS OF FOOD ENGINEERING, Vols. 2 and 3. By Milton E. Parker, E. H. Harvey and E. S. Stateler, Reinhold Publishing Corp., New York, N. Y. Price: Vol. 2 (360 pages), $8.50; Vol. 3 (241 pages), $6.75.

Knowing what must be done to a food is only part of the requirement of successful processing. Knowing how to do it is equally as essential. That is where the subject of these two volumes—unit operations and processes—enters the picture.

As the authors put it in the introduction to Vol. 2: "The Unit Operations concept of food engineering primarily concerns the physical means and equipment used to effect the changes in composition or form which characterize processed foods. Thus, all the various operations involved in food processing can be reduced to certain basic operations which have common objectives; the techniques or methods may vary in detail, but not in principle."

It is this similarity in the operations performed in processing different types of foods that has enabled one branch of the food industry to borrow better methods from another. Witness the bakery plasticizing bulk liquid shortening today with a machine introduced in the dairy industry a quarter of a century ago to freeze ice cream continuously. That is but one of the hundreds of instances where advanced methods have been interchanged among different branches of the field.

Yet technical or management men involved in processing one type of food often are not aware of all the various ways of performing a basic operation, such as separation. So, a hearty "Amen" to this statement in the introduction:

"Lack of appreciation of the true significance of unit operations often constitutes a 'blind spot' in the analytical thinking of many practical food plant operators, and thus obscures obvious solutions to operating problems."

If for no other reason than to remove the blind spot, these two volumes are valuable reading for people responsible for quality, capacity, and costs in food factory operations.

And any student preparing for a technical career in the industry should have in his head the information that lies between the covers of these volumes. That applies even to the student specializing in one branch of food processing.

In discussing the various unit operations, the authors have logically grouped them into four sections pertaining to the (1) assembly, (2) preparation, (3) and conversion of raw materials; and (4) to the treatment of finished products.

Vol. 2 leads off with a very pertinent explanation of the causes of food loss and spoilage. Then follow chapters on: Materials Handling, Separating, Cleaning, Disintegrating, Pumping, Mixing, and Heat Exchange.

Vol. 3 continues the discussion of operations with chapters devoted to Evaporating and Distilling; Dehydration and Drying; Controlling; Coating, Decorating and Forming; Packaging Materials and Packaging Methods.

Each chapter constitutes a "roundup" discussion of ways of performing a particular operation—methods and machines (or materials, in the first packaging chapter). These are pinpointed to different products where specialization is involved. Operating principles are explained and types of equipment are illustrated in pictures or drawings. Some practical engineering data, charts, and formulas are presented.

(Continued on page 20)

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BOOKS

(Continued from page 18)

In evaluating these volumes, however, technical men in the food industry should realize that the title is "Elements of Food Engineering." So the information is necessarily fundamental in character and broad in scope.

Therefore, a particular chapter may not be especially helpful to a reader already well versed in the unit operation discussed in those pages. Nor is enough engineering information always given to permit final selection of a particular method for a particular purpose, or to make in-process performance calculation possible. Among the best in this respect are the chapters on Evaporating and Distilling, and Dehydration and Drying.

To fully serve the needs of a practicing food plant engineer, a great many more pages of engineering information would have to be devoted to most of the unit operations. Yet everyone concerned with food processing can profit by thinking in terms of unit operations and processes.

Upon sound food engineering will, to a great extent, depend the future success of all food manufacturers. And unit operation know-how is the cornerstone of sound food engineering.

Consequently, the two volumes are highly recommended reading.

FRANK K. LAWLER
Editor, *Food Engineering*
New York, N. Y.

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1955

January 10-13	Training Conference, Refrigeration Research Foundation, Edgewater Beach Hotel, Chicago
January 18-20	Sixth Annual Food Processor's Workshop, University of Maryland, College Park, Maryland
February 21-24	International Food Show, New York, N. Y.
February 22-24	Technical School for Pickle and Kraut Manufacturers, Kellog Center, Michigan State College, East Lansing, Michigan
March 7-10	American Society of Bakery Engineers, Edgewater Beach Hotel, Chicago, Illinois
March 8, 9	Third Annual Dairy Engineering Conference, Michigan State College, East Lansing, Michigan
March 13-17	Frozen Food Industry Convention, Hotel Hilton, Chicago, Illinois
March 13-17	National Association of Frozen Food Packers, Hotel Hilton, Chicago, Illinois
March 29-30	National Conference of Interstate Milk Shipments, Hotel Peabody, Memphis, Tennessee
March 29-April 7	The 127th National Meeting of the American Chemical Society, Cincinnati, Ohio
April 30-May 2	American Academy of Applied Nutrition, Pasadena, California
May 15-19	Annual Meeting of the Association of Cereal Chemists, Chase Hotel, St. Louis, Missouri
May 22-26	International Bread Congress, Hamburg, Germany.
June 12-16	**Institute of Food Technologists, Deshler-Hilton Hotel, Columbus, Ohio**

(Information concerning future dates of national and international meetings, conventions and exhibits of interest to food technologists should be sent to the editorial office.)

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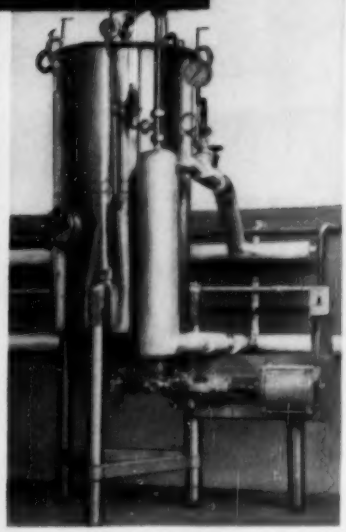

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The Life and Accomplishments of Edwin Bret Hart

EDWIN BRET HART
His Life and Memories of Him

HENRY T. SCOTT
Wisconsin Alumni Research Foundation, Madison, Wisconsin

AFFECTIONATELY known to all of his students as the "Old Man," E. B. Hart was not only a great stimulus to his students, but as we now all well realize, his influence, in biochemistry, medicine and nutrition, was far reaching and lasting. Hart in turn was tremendously inspired by Dr. S. M. Babcock. It might be considered that E. B. Hart was the coach, Babcock the adviser. Together they gave biochemistry, nutrition, and food technology a lift that carried forward and upward these young and developing scientific fields—fields that have had a tremendous influence on the growth of a nation and resulted in better health for both man and animal.

Edwin Bret Hart

Curiously enough, both Babcock and Hart were avid sports fans, and I can think of no better tribute to pay them than to say that they were to their own field of endeavor what Ruth and Gehrig were to baseball. Ruth and Gehrig came along at a time when baseball as a sport was in the doldrums; however, the home run just about reincarnated the sport, and like an electric impulse, the game was on its way again. The "home runs" made by Hart and his adviser Babcock in the field of science, although not recognized at the time, are apparent to everyone as the story of their scientific endeavor unfolds.

EARLY YEARS

Edwin Bret Hart was born near Sandusky, Ohio, on Christmas day, December 25, 1874, the son of William and Mary Hess Hart, the youngest of fourteen children of a family of seven boys and seven girls. He was raised by older brothers and sisters because his mother died in his infancy.

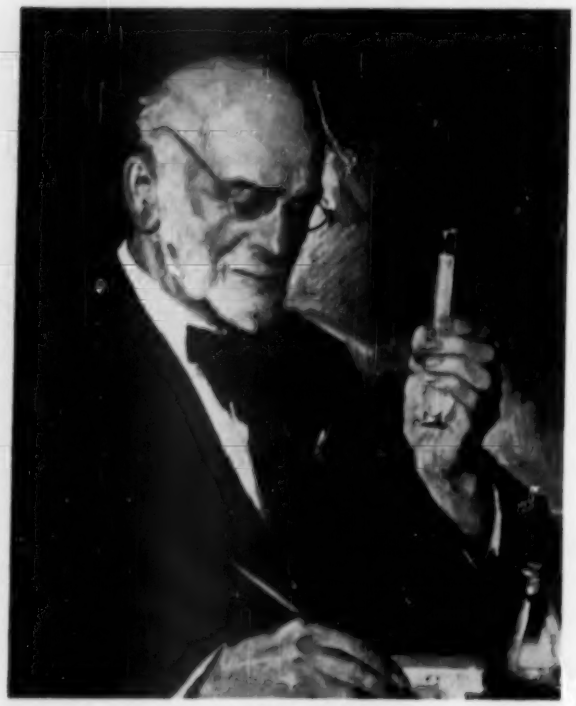
As a student in Sandusky High School from which he was graduated in 1892, he came in contact with Dr. E. L. Moseley, a teacher of physics and biology, who first interested him in these subjects. Professor Moseley's fine character served as an inspiration for E. B. Hart to pursue a career in science.

Upon graduation from high school, Hart matriculated at the University of Michigan where he studied chemistry and medicine. He took the usual required courses and studied under such men as Professor V. C. Vaughn, and Professor F. G. Novy. He was an assistant to a distinguished professor of analytical chemistry, Dr. E. D. Campbell, who, having lost his sight due to an explosion in the laboratory, called upon young Hart to read to him, or to steer the tandem bicycle for Professor Campbell's pleasure rides after working hours. On weekends it was quite common for Campbell to ask Hart to chauffeur him to Detroit, some thirty-five miles away, on this same tandem bicycle, minus paved roads. Hart admitted that Campbell often supplied most of the power.

Hart was graduated from the University of Michigan in 1897 and almost immediately accepted a position at the New York Agricultural Experiment Station in Geneva, where he became assistant chemist. Hart's was not a case of picking the job exactly desired, but, rather, one that demanded his taking whatever position was available.

The first six months at Geneva were spent analyzing feeds and fertilizers, and devoted strictly to control. Being of an investigative nature, Hart asked Director Jordan for a change from this type of work and was transferred to the research end, being placed under the direct supervision of L. L. Van Slyke. Van Slyke was interested in animal experimentation, and Hart had the opportunity of studying dairy problems, animal nutrition, and phosphorus compounds. Hart's work with Jordan and Van Slyke gave him a new approach to experimental work, a position he held from 1897 to 1902. He was granted a leave of absence in 1900 to study in European laboratories from 1900 to 1902. Thus at the very beginning of the century he set out for Germany to study under the famous biochemist Albrecht Kossel, who was then at Marburg. Hart's chief interest

was in the field of protein chemistry, because very little was being done in this country on proteins at that time. Hart intended to secure his doctorate; however, while engaged in studies toward this end, his major Professor, Dr. Kossel, accepted a position at Heidelberg and Hart went with him. Because of the fact that much of Hart's work at Marburg was in the Medical School where only M.D. degrees were given, considerable academic credit was lost due to his transfer to Heidelberg. Although he spent several months pursuing his work preparing for his doctorate examination, Hart decided that the extra time necessary (because of the transfer) to secure his doctorate did not warrant his remaining to complete it. He therefore returned to Geneva where his presence was sorely needed.



Stephen Moulton Babcock

Professor Hart always felt that the right kind of training and experience was as valuable as a degree. He thoroughly enjoyed the student life at Heidelberg and often indulged in reminiscences of his experiences at that institution. While there, he paid all of his own expenses, and purchased with his own money most of the supplies which he used in his own laboratory. In later years, when graduate students were dissatisfied with the small stipend which they received, he would refer to his early experiences when he had to borrow money for advanced work.

HIS CAREER BEGINS

Upon his return to Geneva in 1902, he was advanced to the position of associate chemist, a post he held until 1906. His work in the field of animal nutrition was pursued with renewed vigor after his European studies, as he was now better equipped as a result of this training.

In 1906, W. A. Henry, Dean of the College of Agriculture of the University of Wisconsin, suggested to President Van Hise that someone be employed to take the place of Dr. S. M. Babcock who desired to retire. Dean Henry had previously met Hart and had observed his work while visiting Geneva on different occasions. Consequently, Van Hise wired Hart to meet him on the train at Syracuse and ride with him to Albany, and it was during this ride that Hart's first interview with Van Hise took place. Van Hise was impressed with the man, and a few days later after returning to Madison he wired Hart and offered him the position of full Professor of Agricultural Chemistry. In view of the fact that Dean Jordan at Geneva had informed Hart that he could not advance much further, Professor Hart had no hesitancy in accepting the Wisconsin position.

It is no secret that the then new but nevertheless pioneer work which Hart did in connection with proteins, phosphorus compounds, dairy science and the chemistry of cheese ripening were influential in his being chosen for the job. As a matter of fact, Babcock himself had suggested Hart as a result of published papers on the aforementioned subjects which had emanated from the Geneva station, all bearing Hart's name. When Hart came to Madison, the research and teaching in agricultural chemistry were immediately put under his able direction. He carried on where Babcock left off, because Babcock desired to probe into the realm of the unknown, for his curiosity knew no limits.

Having been appointed full Professor in 1906, Professor Hart was made chairman of the Department of Agricultural Chemistry and chemist in the Experiment Station, a position he held until his retirement in 1945. Undoubtedly, one important factor which attracted him to Wisconsin was that Dr. S. M. Babcock had been at the Geneva Experiment Station from 1882 to 1888 and Hart had become acquainted with his work. Hart always emphasized the practical application of the subjects he taught in order that the world might he a better place in which to live. As a matter of fact, he was not just a supreme teacher and unsurpassed research director, but a salesman of knowledge. Although his greatest influence was reflected in his graduate students, it is noteworthy that for many years General Agricultural Chemistry was a required course for all graduates of the College of Agriculture (a four year course) and in this course Hart's lectures were classical. Without exception, students who had only one course under him still remember something of the lessons he taught; other professors or courses may have long been forgotten, but no one who came under Hart's influence could forget the man. A favorite piece of advice that he always gave at the end of the course was: "Now don't go back home and tell your Dad how to run the farm just because you have been subject to a lot of college training. After all, your Dad has been farming for many years and knows a few things—else you wouldn't be here."

SOME SIDELIGHTS

Professor Hart was married in 1903 to Annie Virginia DeMille, a relative of the famous family so well known in the movie and theatrical world today. Mrs.

Hart was interested in the stage and in the theater right up until her death, June 28, 1936. To this union one daughter was born, Margaret Hart Larson.

Professor Hart loved to travel, to go to new places, see new things. He was an ardent sports fan and rarely missed an athletic contest, as his home almost adjoined the stadium and field house of the University of Wisconsin. His favorite recreation was golf. His interest in sports was probably kindled while a member of the baseball team at the University of Michigan. Professor Hart belonged to a number of professional societies such as the American Chemical Society, the American Institute of Nutrition, and the American Society of Biological Chemists; he was an adviser of the Protein and Nutrition Division of the Bureau of Chemistry and Soils, as well as an adviser of the Vitamin Division of the Federal Security Agency, Food and Drug Administration, the American Association for the Advancement of Science, the American Dairy Science Asociation, and the Society for Animal Production. He was a member of Alpha Chi Sigma, Alpha Zeta, Phi Lambda Upsilon, Sigma Xi, Phi Kappa Phi, and an honorary member of Phi Beta Kappa.

He received several professional awards and honors, among which were the Borden award from the American Dairy Science Association (1941) and the honorary degree of Doctor of Science from the University of Wisconsin (1949). He was elected to the National Academy of Sciences in 1944, an honor which he treasured highly, but unfortunately he never attended a meeting of the Academy. He did not enjoy meetings; when he did go to the national meetings, one or two baseball games were usually included in the itinerary. His failure to attend scientific meetings was unfortunate because he had much to contribute, and many would have liked to become better acquainted with him.

PERSONALITY AND CHARACTER TRAITS

Professor Hart's pleasing voice and affable manner made him an effective public speaker both to scientific and lay audiences. He was frequently called upon to give public addresses, but he turned down a very large percentage of the invitations. He realized that he could not give a good lecture without proper preparation, and he never failed to take the necessary time for such preparation. Whenever he did accept a speaking engagement, his paper would be ready for delivery months before the scheduled time.

Professor Hart was a perfectionist; he was always on time. Leaving his home at 7:30 in the morning, he would first make a tour of cooperative research projects in the Agricultural Experiment Station in the Poultry, Dairy, and Animal Husbandry Departments. He knew everyone and always had a kind word for the herdsmen, ground keeper, and janitors. Arriving at his office shortly before 8:00 A.M. he made his usual tour of the building, which enabled him to keep abreast of the progress of work of graduate students and members of his staff. While most of his questions and comments were intended to stimulate and encourage, he applied the proper philosophy in each case as it seemed warranted—and Hart always knew what was warranted, encouragemen to one, praise to another, a prod here, and a warning there, as it was needed. For many years Professor W. H. Peterson gave an elementary course in the department for Home Economics students. Hart would delight in visiting the laboratory in this course and asking the girls what they were doing. Usually he received intelligent answers; however, on one occasion one of the girls turned to him and said "I don't have to answer questions asked by the janitor." The reason for this reaction was undoubtedly due to the fact that he seldom wore a laboratory jacket while making the rounds, but would generally take his coat off and use a small piece of toweling or cheese cloth as an apron. This apron was not changed too frequently, and often, perhaps, he did look like a janitor. However, no one ever enjoyed this tart reply more than Professor Hart, and he told this story on himself frequently and with complete good humor.

Professor Hart, possessed of great personal charm and a keen sense of humor, was a brilliant conversationalist and a delightful companion. Upon returning to the campus his former students never failed to call upon him. Hart was always ready to discuss problems, and upon entering his office you received at once an indelible impression. He would arise from his chair and with his arm fully extended walk towards you, his face wreathed in smiles, and give you a cordial greeting. His actions meant a whole lot more than spoken words. He was always interested in the progress of his former students and often gave them helpful advice that they could use when they went back to their own laboratories.

HART AS A TEACHER

Anyone who was associated with him and who judges his capabilities in an unbiased manner is ready to say that he excelled as an administrator, as a teacher, and as an investigator. His accomplishments as an investigator speak for themselves in his scientific publications, and these are well known to all who are interested in nutrition. However, only those who had more close contact with him appreciate his capabilities in directing his department and in teaching students, both undergraduate and graduate. One thing that stands out in all his activities is his sense of the practical. His teachings never dealt with vague theories or philosophies. He dealt directly with established facts and segregated them clearly from the field of the unknown. He had rare ability to make a complicated subject seem simple and interesting. When it came to quizzing his students, either in the classroom or in the laboratory, he could be the most inquisitive individual that you could encounter —just brief questions, right to the point, which inquired with amazing acuity into a person's thinking processes and knowledge. He rarely discontinued questioning a student in the classroom until he found something that he did not know and then would end up with a remark, "You don't know that? You'd better look it up."

A MAN OF GREAT ADMINISTRATIVE ABILITY

As as administrator he worked hard to keep his staff intact. There were few losses of personnel from his department over the 38 years that he served as its head.

He expected much from his associates, but he never attempted to direct their work or indicate what problems they should study. The growth of his department from the time he assumed control to its present size is a monument to his ability as an administrator. Such steady growth and increased output could not take place without sound guidance.

The more spectacular observations—such as the production of vitamin D with ultra violet rays, the function of copper in hemoglobin formation, the use of nicotinic acid in pellagra, and the fascinating story of blood anticoagulants—have not been chance observations—but the result of systematic and well considered approaches to the solution of practical problems of immediate interest. Hart was always ready and willing to give others who had done the work the credit, but it is equally true that there was a true guiding hand behind it all, which is equally responsible for the accomplishments.

Professor Hart served on relatively few University committees, although he was an efficient committee member and worked hard on the appointments which he did accept. In 1919 the Research Committee of the Graduate School was organized, and Hart's services to this group were both fruitful and enjoyable, because it was organized to help stimulate research in the University; later on, this same committee served to make grants to the faculty and staff members for research. Hart served almost continuously on this committee except for a short period during the time of President Frank. However, at a later date he was re-appointed and served as chairman for one year; he maintained high standards in research and was not afraid to tell his colleagues that projects which they submitted did not appear to be of the quality necessary for support from the Research Committee. On the other hand, he was enthusiastic about good projects and would not hesitate to compliment those who deserved it.

The Hart family was not socially inclined. For many years it was customary for them to proceed to the tip of Door County, Wisconsin, where they had a cottage on Green Bay. It had more non-modern inconveniences than one would expect in such a cottage, and during the summer it was a case of more or less roughing it. Professor Hart loved sailing on the Bay, swimming, and tennis on the courts adjacent to his cabin. Mrs. Hart died June 28, 1936, but Margaret, together with her husband Professor Russell Larson, lived with him in his family home.

"A TRUE SON OF THE MIDDLE BORDER"

On March 11, 1953, Professor Hart came to the laboratory as usual; although he had been officially retired for almost eight years he visited the laboratories daily and continued his interest in all activities in the department; he left the laboratory at four o'clock and spent an uneventful evening at home. During the night he was stricken with a coronary attack and died on March 12, 1953. E. B. Hart, a true son of the middle border, a minister in the evangelism of technical progress, always pursued his work with eagerness, fullness and fidelity. He was a delicate ear trumpet through which his students could whisper their joys and their sorrows, their convictions and their sympathies—and he always listened for their coming.

Thirty-two Years' Association with E. B. Hart

C. A. ELVEHJEM
University of Wisconsin, Madison

To begin at the beginning—I first met Professor Hart when, as a sophomore in the College of Agriculture, I took his course in Agricultural Chemistry I during the spring of 1921. I had taken general chemistry and analytical chemistry, but this course was most stimulating to me since it introduced me to the chemistry of living matter. What makes a plant grow? Why do animals fail to develop normally? The class was a large one since we were then experiencing the bulge in student enrollment after World War I, but even so Professor Hart was able to call most of the students by name. In the midst of his lecture he woud stop to ask questions, especially of those students who looked sleepy.

As those of you who have taken any of his courses know, the basic information was placed on the blackboard, and he spent most of his lecture giving interesting incidents in relation to these facts or bringing in practical applications. I am afraid he would encounter some difficulty today when our classrooms are used so extensively. But in his day he always lectured at 11:00 A.M., and the material on the blackboard was put on at 8:00 in the morning. In fact, it was a very good idea for graduate students preparing for their final examinations to take a look at the material on the blackboard during the few days previous to their examinations. One student told me after his examination that he never expected to be asked questions along the line of the test. I took him to the auditorium and indicated that if he had taken a look at the blackboard, he would not have been surprised. I had no further contact with him until the end of the first semester of my junior year.

E. B. HART AS A PERSON

I had some difficulty in deciding what field I should major in but by that time I had decided on agricultural chemistry or biochemistry. When I went to visit Professor Hart in his office, he immediately recognized me as one of his former students but he made no comment until he had looked at his record to see what grade I had received in his elementary course. Incidentally, his office did not change one iota from that day until he moved out of the office 20 years later. Not one drop of paint had been used in that room. In fact, when his

secretary and the head painter implored him (about once a year) to have the office painted, he would roar, "No damn painter is going to mess up MY office!" His only comment to me on that day was, "So, you want to be a chemist." Then he went on to say, "I think you're very foolish. You have to work very hard and you'll never make any money. The only way you can get along is by finding yourself a rich wife." Then during the next half hour he gave as interesting a summary of biochemistry as I have ever heard. He described briefly some of the work that he was doing, the opportunities for the future, and the importance of young men taking up work in this field. He agreed to be my major professor.

During the first semester of my senior year I took his dairy chemistry course. Although Dr. Scott has indicated Professor Hart's deep-seated interest in sports, some of us were amazed to find that the first hour examination in this course was given at 11:00 A.M. on homecoming day. This, I think, demonstrates his philosophy of discipline as well as anything can. He enjoyed sports, travel, and many other things—but he never let them interfere with his work. Although this course was given for juniors and seniors, almost every year one to three graduate students would be enrolled. Professor Hart would enjoy asking them the more practical questions and it made for a most interesting discussion. I suppose the story which is best known relates to the question of how a farmer would determine when it would be safe to enter a silo after filling it with ensilage. Naturally, the answer which Professor Hart wanted was one that made mention of a lantern, to see whether or not there was sufficient carbon dioxide remaining to extinguish the flame. In this case the bright young graduate student answered, "Send the hired man in and see if he survives."

Toward the end of the semester Professor Hart entered the classroom, pointed his finger at me, and said, "Elvehjem, I want to see you at the end of the class." Naturally, I wondered what I had done to be called on the carpet. After all the students had left at the end of the class period, he looked at me and said, "How would you like to help teach Ag Chemistry I next semester?" I said, "That would be most interesting but I still have a semester of work left in order to graduate in June." That didn't seem to faze him in the least, and he said, "Well, we'll plan on you for next semester." The semester came to an end, and I heard nothing further from the professor. I had two days between examinations and I went home for a short visit. I had only been home a few hours when I received a long distance call from Madison. It was Professor Hart telling me that he wanted to see me as soon as possible. When I reached his office the next morning, all he said to me was, "Take off your coat, go down to the laboratory, and help Carl Hoppert prepare for the laboratory work." This was also typical.

PROFESSOR HART AS AN ADMINISTRATOR

He wasted no time in his administrative duties. For many years he ran the department without staff meetings. When he appointed a graduate student as an assistant, he was continued in that appointment regardless of the fact that he might benefit from other appointments which gave him more experience or more money. I remember very well after I joined the staff, I suggested that certain students be shifted from a half-time assistantship to a full-time assistanship. I was literally thrown out of his office, but I am happy to say that within a few years he agreed that this was a satisfactory procedure. Professor Hart did not tell his teaching assistants how to teach, but he did know whether they were a success in the classroom. He made suggestions which you did not realize at the time related to your teaching program, but as time went on you recognized that they were most helpful. I might add that during that semester I carried two sections in addition to my regular senior work; I am sure it would have been of no benefit to indicate that I was overworked. In fact, at the time of the final examinations the papers assigned to me were to be graded at a definite time even though I myself was scheduled to write a final examination in physical chemistry the following day. I mention this because today graduate students often object to teaching because it encroaches on their research work.

As a graduate student in the department I was impressed by two things. First, the general seminar conducted by Professor Hart and attended by all the graduate students in the department. This seminar was scheduled for 4:30 on Tuesday afternoons and usually lasted until 6:00 or 6:30 P.M. He would be very annoyed if anyone left before the meeting was dismissed, and this made it difficult for some of the students who lived at a fraternity and were scheduled to eat the evening meal at a definite hour. Professor Hart would not hesitate to interrupt the student at any time during the presentation of his talk. However, at the end of the seminar he would always have a personal comment to make. If the topic had been presented well he would tell the student he had done a good job. If the student had done poorly, his weak points would be pointed out to him. Second, it was obvious that Professor Hart contacted his own graduate students every day. He would not ask them to come to his office, but he would make the rounds of the laboratories and stop to talk to each individual, look at his notebook, and frequently add his own notations. If the student needed special supplies or special equipment, he would go right back to his office and make the proper arrangements immediately. In fact, he would probably call the purchasing office every day until the material was delivered. I said he would see his students every day. There were two exceptions. One, if he had a budget to prepare, he would lock himself in his office until it was finished. Fortunately, it took him only a relatively short time to prepare the budget since he was not given to long and detailed considerations. The other exception was during the summer when he would leave Madison the weekend before the last week of summer session and return the day after Labor Day. For almost 25 years I knew no exception to this rule. He would travel to his cabin in the northern part of Door County just outside of Ellison Bay and enjoy a complete vacation. The secretary did send him the scientific journals as they

arrived and when he returned he usually had some new ideas for research.

AN OUTSTANDING TEACHER

Professor Hart was known as an outstanding teacher and would let nothing interfere with his preparation for his lectures. We soon learned that the hour before his lecture was not a time to go see him. However, he did not have the same respect for those of us who also carried on teaching. While I was a teaching assistant and later as a member of the staff, I was interrupted many, many times by having Professor Hart come to the laboratory to discuss urgent research problems. If he would find a new statement in the literature related to the work we were doing, he would bring it right to the laboratory and discuss it at that time. This demonstated his complete enthusiasm for research. Nothing pleased him more than to see experimental data demonstrate a new fact. He was equally enthusiastic whether these observations were made by himself, his students, or anyone else in the department. Once in a while he was overly enthusiastic and would talk about results before they were finally proven. The most significant aspect of all of his research was the fact that after he had once started work on a given problem he would not deviate until final results were obtained. It made little difference to him whether the results were positive or negative as long as the answer was finally obtained. Although he followed the literature very closely and would make use of every new finding in promoting his own research, he would never change his approach until he reached the end which he had in mind. It was interesting to observe that his approach was usually from an analytical point of view, and I imagine this was due to his early training in analytical chemistry. When results were obtained, he immediately put the data together for publication. He worked very hard in writing his papers, and they were always very well done and presented in simple but appropriate language. When he had completed a paper and submitted it for publication, it was finished as far as he was concerned. He was much irritated if a paper was returned by the editors even for very slight modifications. On numerous occasions he immediately dictated a most critical letter in answer to the editorial suggestions. However, after dictating, he usually left the letter on his desk until the next morning. Then he reread it, and often he asked one or two of his students or colleagues to read it. Thereupon, the letter generally went into the waste paper basket.

Professor Hart was well known for his cooperative work with members of other departments, and in almost every case he took the initiative in preparing the results for publication. However, after the preparation he was very careful to give credit to everyone who had contributed anything to the project. He took every assignment very seriously and I believe he worried more about the project than most people were led to believe. With age he mellowed and enjoyed his work to a much greater extent. Certainly, I know of no one who enjoyed his retirement more than Professor Hart. He continued his interest in research and was especially helpful to all members of the department. After his retirement, much to my surprise, he definitely did not interfere with any administrative actions or decisions. He would often make suggestions but would conclude his suggestions by saying he no longer had any authority in these cases. As has been indicated, Professor Hart rarely attended scientific meetings but whenever he did take part in meetings or conferences, he always came back with enthusiastic stories. He was able to relate what took place in the conference in a very interesting manner. Upon his return he would start immediately to tell what had happened without any suggestions or questions. I believe those of us who had the privilege of working closely with Professor Hart will agree that our most interesting sessions were those on a Sunday morning or the morning of a holiday. He was always in the laboratory on these occasions and it was then that there were no limitations on our discussions. They included politics, economics, social problems, and so on. His discussions would include anyone present, the students, janitors and animal caretakers. He was exceedingly well read and could discuss intelligently almost any of the problems of the day. He was not hesitant in proposing his own solutions for many of the world problems although I think in his own mind he realized that they were merely his own solutions. He was very critical of research workers in other fields and felt that in many cases they were wasting their time. When he served on the Research Committee of the Graduate School, he did not hesitate to express his candid opinion about certain research workers. However, he was also very willing to gamble in the support of young investigators.

A total of 46 students received their Ph.D. degrees under Professor Hart. Thirty of these received their training during my association with him. I believe we can truthfully say that he did not give too much attention to the selection of his students. But usually he paid considerable attention to the performance of the student if he had taken any of his classes. However, he seldom took time to look at their scholastic records. He paid relatively little attention to the registration data on students and often did not know if they had completed the formal requirements. But he did instill in each and every one the true spirit of research. He did not tell them what to do but he was always ready to make suggestions if he thought that the approach or techniques were not satisfactory. He had an uncanny ability to find errors in a thesis or in a paper which was being prepared for publication. Few, if any, students left the laboratory after receiving their degrees without publication of one or more papers based on their theses.

CHARACTERISTICS OF HIS HUMAN CONTACTS

He was helpful in finding jobs for his students although he did not go out of his way to initiate opportunities. I believe he felt that well trained students were sought after and that it was unnecessary for him to go out to find jobs. This was true except in the depth of the depression when some of the students failed to find jobs upon completion of their training; he kept them on as research assistants—a starvation wage for a Ph.D. but nevertheless it was most helpful in tiding them over this difficult time.

His contact with students after leaving the laboratory was outstanding. He corresponded with many of them, helped them find new positions if needed, and gave them advice both in their research work and in their personal problems. He was always glad to see the students when they returned for a visit. In later years it was always a pleasure to bring a visitor to his office; he was most gracious and would go out of his way to make the visitor feel at home. This was not always the case when I think back on my earlier associations with him; he would often find a sudden excuse in those days to go into a far corner of the building in a dark laboratory or washroom when he saw certain individuals on their way to see him. I believe it was an effort for him to visit with certain individuals, but when he made up his mind to do so it would be most difficult to even imagine that he was not enjoying the conversation to the utmost.

In many respects he was shy and his gruff manner in his earlier days was undoubtedly an effort to cover up this shyness. He openly scoffed at honors, but nevertheless I am sure he appreciated the recognitions which he received. He was truly pleased by his election to the National Academy of Sciences, but in referring to it he usually laughed it off. When his students and friends decided to have a portrait painted of Professor Hart, it fell to Professor Peterson and me to approach him and get his approval. The answer was a definite *no*, and we were shown to the door. As we left, Professor Peterson was greatly disturbed and said, "What can we do now?" I told him I would talk to Professor Hart further, and after about two weeks he gave his approval but with no enthusiasm. Nevertheless, I know he was pleased to have this portrait made.

A MEMORABLE TRIBUTE

The recognition which he truly appreciated was his honorary degree from the University of Wisconsin in 1949. I had the privilege of escorting him on that occasion, and I know that he was deeply appreciative. In this connection I would like to read the statement which Professor Kiekhofer gave in presenting him for the degree:

"For nearly forty years the central figure in this University in the fields now called nutrition and biochemistry. Although he became an emeritus professor five years ago, his daily appearances in his beloved laboratory are of such clock-like precision that other time regulators are superfluous. This puts him in a class with Immanuel Kant and E. B. Fred, the latter more especially as to early morning hours.

"Because, profiting by his scientific studies in Germany and his early associations here with Babcock and Henry, and later with Russell, he has brilliantly continued and himself contributed to the ideas of this triumvirate for the advancement of science and the betterment of agriculture.

"Because there have been combined in him the rare gifts of an able scientist, a great teacher, and a sound administrator—tireless, modest, and unselfish in all relations.

"Because under his inspiring leadership and example a galaxy of great young scientists was developed who independently and in cooperation with him blazed new trails, made new discoveries, and worked out applications of great benefit to mankind.

"Because out of the nationally prominent center for research in nutrition and biochemistry developed here to so large an extent under his direction and influence, there came fruitful research in vitamins, irradiation of foods, penicillin, dicumarol, and the like, I present to you, Mr. President, one of your own long-time associates in research, Edwin Bret Hart, upon recommendation of the Faculty and by vote of the Regents, to receive the honorary degree, Doctor of Science."

FURTHER INSIGHT INTO HIS HUMAN QUALITIES

He was always interested in children. If youngsters happened to come through the laboratory he would soon determine whether they were interested in seeing the laboratory or whether they were on a mischievous mission. Some of the boys would return many times and visit with Professor Hart and look at the animals. Miss Terrio, who has been secretary in the department for many years, once brought her young nephew to the laboratory to meet Professor Hart and they became real pals. He took him to see the monkeys and went through all kinds of antics in order to amuse the youngster. He always remembered these children on Valentine's Day and would go to the store and make his own selections although it was Miss Terrio who would address and mail the cards.

Professor Hart enjoyed an argument but in many cases it was difficult to convince him of your point of view or to modify his original concepts. The examples which stand out most clearly in my mind are the arguments which we had over paired feeding and the use of fluoride in the prevention of dental caries. For several years in our Journal Club we had arguments over the virtues of paired feeding, and it appeared to me that I was making no headway in presenting the limitations of this procedure until one day suddenly Professor Hart clearly outlined all the objections which I had tried to present over several years to the Journal Club. After that he was thoroughly sold on the objections, but he never indicated in any way that previously he had taken the other side. He was opposed to the use of fluoride in the treatment of dental caries, undoubtedly due to his earlier experiences with the toxicity of this element. If you asked the specific question—is 1 p.p.m. in drinking water toxic?—he would answer *no*, but nevertheless he thought it a dangerous procedure. I often asked him how he could be so enthusiastic over iodized salt when he was opposed to the fluoridation of water. He had no answer for this except to say that he was very much in favor of the former. In all of these experiences the arguments were always friendly and he had no objection to anyone taking the opposite side.

It was a tremendously interesting experience to be in contact with one who has the courage of his convictions; there are too many individuals these days who are readily swayed by a few unsubstantiated statements. Few teachers have so vividly impressed so many students in the field of biochemistry. I cannot overemphasize how deeply grateful I am for having been one of these students.

Contributions of E. B. Hart to Animal Nutrition

S. LEPKOVSKY
University of California, Berkeley, Calif.

WE ARE now living an historical moment in nutrition, dedicating it to Edwin Bret Hart and to his work. We respected him as students and with the passing of time our respect has been tempered with reverence. In a sense, we, his students, are dedicating this moment to ourselves because ours were the hands that carried out his work.

E. B. Hart helped to usher in a new era in nutrition, the era of essential nutrients and he has passed on as we are witnessing the termination of that era. He demonstrated with heifers as the experimental animals that rations prepared from the whole oat plant, the whole wheat plant, and the whole corn plant—although identical in their content of protein, energy, and ash—gave different results in terms of growth, reproduction and well-being. As a result of these studies he was able to show: (1) the existence in natural feedstuffs of unidentified nutrients essential for the growth, reproduction, and well-being of heifers; and (2) the importance of including observations on the reproduction of animals in nutritional investigations.

E. B. Hart made important contributions to the nutrition of farm animals. This stemmed from his basic philosophy that sound nutritional investigations can be carried out with animals of economic importance just as well as with rats and such other animals as are not of economic importance. He investigated all manner of practical problems but he never did any practical research. No matter how practical the problem studied, it was always handled in the most scientific manner and received the most searching investigation with the best techniques available.

Much of his research effort was devoted to the study of the nutrition of the ruminant. He demonstrated by a long series of investigations that farmers could grow on their own farms the bulk of the feeds needed to maintain a high level of milk production. He determined the conditions under which urea could safely replace a large part of the protein of the ration of the ruminant, thus increasing the available supply of proteins for chickens and pigs. He studied the vitamin and mineral needs of the ruminant and helped in the formulation of modern balanced rations for ruminants.

In swine nutrition he studied iodine deficiency and helped to establish the role of iodine in the prevention of hairless pigs. Once the need for iodine in rations was established, he and his associates worked out means of stabilizing iodine, so that once it was incorporated in feeds it remained there until consumed.

When E. B. Hart got his teeth into a problem, he investigated every phase of it. No detail escaped his attention. This is especially evident in his studies with the chicken. He laid the foundations of the modern broiler industry when he solved the problem of leg weakness from which chicks died during the winter but not during the summer. Leg weakness proved to be identical with rickets which was curable by either sunshine or vitamin D. He was the first to experimentally prevent leg weakness by exposing the growing chicks to sunshine.

He investigated calcium and phosphorus metabolism in the chicken and its relation to vitamin D. He examined critically and scientifically the sources of calcium and phosphorus for the feed industry, more especially dolomitic limestone and rock phosphate. This resulted in basic nutritional studies of magnesium and fluorine which accompany the limestones and rock phosphates. He studied the availability of nutrients in feeds, more especially organically bound phosphorus and iron. His demonstration that copper is needed for the incorporation of iron into hemoglobin is a great classic; Elvehjem reported that when E. B. Hart read the paper before the Society of Biological Chemists, he received a standing ovation. Only a few, a very few, have been so honored.

In some respects he was ahead of his time. He always insisted that the milk proteins deserved equal economic consideration with milk fat. Had the dairy industry listened, they might have avoided some of their present difficulties.

We try to express our feelings, as best we can, toward this great man who is no longer in our midst. I have found a document written in 1841 that goes a long way, I believe, in expressing how many of us must feel. It is a letter from Justus von Liebig addressed to the French scientist Thénard and reads as follows:

To Monsieur le Baron Thénard,
Member of the Académie de Sciences

Monsieur,

In 1823 . . . a young foreign student came to you and begged you to advise him concerning the fulminates which he then was investigating . . . he had no other introduction to you except his love of study and his fixed desire to profit from your teachings.

You bestowed on him a most encouraging and flattering welcome, you directed his first researches, and through your influence he had the honor to communicate them to the Académie.

It was the session of the 28th of July which decided his future and opened a career in which for seventeen years he has labored to justify your benevolent patronage.

If his labors have been useful, it is to you that science is indebted for them, and he feels obliged to express publicly to you his ineffaceable sentiments of gratitude, esteem and veneration.

JUSTUS LIEBIG

Giessen, 1 January 1841

The Impact of E. B. Hart's Contributions on Human Nutrition

E. M. NELSON
Food and Drug Administration

IN READING a list of the publications of Professor E. B. Hart covering the 47 years he was actively engaged in research at the University of Wisconsin, one finds reference to studies on all of the nutrients essential to man. Professor Hart's direct contributions to our knowledge of animal nutrition and animal feeding were more extensive, however, than those which he made to human nutrition. The reason therefor is obvious, but even so, his teachings and his contributions to the fundamental knowledge of nutrition science had a profound, though indirect, influence on human nutrition. His appointment to the University of Wisconsin was as Professor and Chairman of the Department of Agricultural Chemistry in the College of Agriculture. Before I became familiar with the operations of the Department, I asked him if, in our research program, we could undertake the study of a problem that dealt more directly with human subjects than the ones with which we were engaged. Professor Hart explained to me at some length that we were in the College of Agriculture and that our first obligation was to the farmers of Wisconsin. This should always be kept in mind as a guiding principle in limiting the sphere of actions. There were plenty of problems in animal feeding to engage our attention. Furthermore, there were many fundamental problems whose solution would find application in man as well as farm animals, and these it may be quite proper for us to study.

Professor Hart was very much opposed to newspaper publicity and he avoided speculation about the possible application of his findings to man in his scientific publications. However, in discussing various problems with his students, even though he did not hesitate to indicate possible applications of new discoveries to stimulate their thinking, he was careful to point out that results obtained in studies on a rat or a cow are not necessarily applicable to man. He objected to newspaper publicity because of the difficulty of getting the story told properly. A scientific discovery should be published in a scientific journal. If the finding was confirmed it would be studied and adopted by the medical profession and the dissemination of information through the extension service was much more reliable and rapid enough for all practical purposes. That, in brief, was his philosophy on publicity.

It is difficult to apply any accurate measure of the impact on human nutrition to his personal contributions, and to the many discoveries with which his Department is credited. Twice a day, once in the morning, and once in the afternoon, Professor Hart made a trip through the building. On these tours he contacted the members of his staff and all of the graduate students, noted progress, made suggestions or criticisms in a manner he thought best suited to stimulate enthusiasm. In this way he contributed towards the solution of all of the problems under investigation. None of the papers from his Department relating to the discovery of Vitamin A, Vitamin B-1, the function of Nicotinic Acid or the production of Vitamin D by the use of ultraviolet rays bears his name. Yet those familiar with all of these developments know that he took part in all of these studies, and no one can question their importance in or direct application to human nutrition.

HIS STUDIES ON CALCIUM REQUIREMENTS

I had the good fortune to visit him about ten days after the discovery had been made that the feeding of nicotinic acid brought about a rapid remission of the symptoms of black tongue in the dog. He was just as elated as if he had made the discovery without assistance from any one. As you know, this important discovery led immediately to the use of the compound in the treatment of human pellagra. In reading the scientific papers in *Science* and in the *Journal of Nutrition* which deal with the role of nicotinic acid in the nutrition of the dog, the scientist of the future will not see the name of E. B. Hart, nor will he realize that behind the scenes there was at work one of the most brilliant minds of our times whose heart and soul were devoted to science. Yet, one must say that his studies and his teachings had a profound influence on human nutrition and in clarifying the thinking of those who dealt more directly with human problems. His studies on the calcium requirements of the lactating cow give much food for thought at the present time when there is considerable difference of opinion with respect to the calcium requirements of man. During the period 1910-1930 there was a keen interest and much active investigation of the calcium requirements of dairy cows. Professor Hart's contributions to an understanding of calcium metabolism in the lactating animal are, of course, widely recognized. After many years of carefully planned research it was established that the cow producing large quantities of milk was always in negative calcium balance during the early portion of the lactating period regardless of the quantities of calcium or Vitamin D incorporated in the ration. It was also established that during the interval between successive lactation periods, a cow whose skeleton had been depleted by heavy milking stored up calcium almost as rapidly on what we regard as a poor calcium ration as on a ration that was fully adequate with respect to both calcium and Vitamin D. This demonstrates beautifully that the bone serves two functions—to maintain skeletal structure, and as a storehouse for calcium. This was not a new thought, but where is there a better demonstration that nature intended that the bone should function as a storage organ? Anyone who is familiar with these studies that covered a period of about twenty years and which were started more than ten years before the discovery of Vitamin D will certainly look with a critical eye on the value of short-term calcium balance studies in establishing human requirements for this element, and the practice of using as a criterion of the requirement the intake of calcium which will produce a positive balance.

STUDIES ON PHOSPHORUS AND OTHER MINERALS

About 1910 Professor Hart and his associates established that inorganic phosphorus could serve as a source of phosphorus for farm animals. That development is certainly an important step in establishing the function of this element which we now know is so important in a host of metabolics reactions. He followed these studies with similar studies on other essential elements and he taught us in 1917 that there was no evidence that organically bound elements were preferable to the inorganic, in fact, the latter were just as good in all of the investigations he had made. That view is equally true today except for cobalt, which for the non-ruminant must be supplied in a very complex organic molecule. This, however, is not a matter of availability of cobalt because inorganic salts are readily assimilated in quantities that are toxic.

About this time he was engaged in studying the relation of iodine to the so-called hairless pig malady, his studies showing that this condition could be produced or prevented at will by controlling the iodine content of the ration, and that it was associated with enlargement of the thyroid which helped to fix attention on the simple goitre problem. He strongly endorsed the iodization of table salt, and when it developed that iodine may be lost rapidly from table salt, he guided the development of a simple method for stabilizing iodine that has come into practically universal use.

The demonstration that both calcium and phosphorus could be supplied to animals as inorganic compounds led to the use of rock phosphate as a source of these elements as supplements to livestock rations. It soon developed that naturally-occurring calcium phosphate contained fluorine in amounts that were toxic to animals. In determining the quantities of this element that could be consumed with safety by cattle, swine, and poultry, Professor Hart became very conscious of the possible injurious effects of this element. In 1952 when a Congressional Committee was taking evidence on the possible harmful effects of chemicals that may be introduced in our foods he appeared before that Committee to urge that caution be used in the fluoridation of our water supplies before having adequate studies for our guidance.

In 1923 Professor Hart began a study of the value of various compounds of iron in the formation of hemoglobin. This culminated five years later in one of the most important, and probably the most spectacular of his accomplishments. He demonstrated that copper was necessary for the formation of hemoglobin in the rat.

This was followed by a study of more than two years' duration, carried out in collaboration with Dr. Dorothy Reed Mendenhall of the Department of Home Economics. More than 160 anemic children of preschool age were observed, some treated with iron alone, and others with both iron and copper. Many of those given iron alone failed to respond, while others made a small and incomplete response. However, 32 children who had shown no improvement with iron alone were then given iron and copper with satisfactory response in every case. A chemical examination of the pharmaceutical preparations of iron on the market revealed that those products contain copper as an impurity—sometimes merely a trace—and in other instances several times the amount necessary for therapeutic use. Since diets were almost as likely to be deficient in copper as in iron, it seems poor medical practice to depend upon chance as to whether or not adequate amounts of copper were present. Professor Hart felt strongly enough about this situation to take out a patent covering the use of iron and copper combinations for the treatment of nutrition anemia.

These studies on copper led to further investigations of trace minerals in nutrition, studies which demonstrated that manganese and zinc are essential for the growing rat. There has been no adequate demonstration of the importance of these elements in human dietaries, but sufficient facts have been established concerning both elements that their possible importance cannot be ignored.

AN INTERESTING LAST CONTRIBUTION

There are few instances in the history of medicine where the conception of an idea, the development of an experimental plan, the carrying out of the experiment, and the experimental subject all resided in the same person. In the last, and perhaps one of the most interesting of his contributions, Professor Hart found a successful treatment for his own condition that had been diagnosed as sciatica.

Before his death, Professor Hart prepared a paper entitled "The Mobility of the Calcium Salts of the Bone and Therapy for Removal of Extra Calcium from the Vertebra or Bone Tissue," in which he discussed at some length the scientific facts that suggested to him a rational treatment for his condition. He then recited his personal experience. This paper has not been published, but with Dr. Elvehjem's consent, I take the liberty of quoting the following from it:

> "In May 1950, the writer began to suffer from what the surgeon called 'Sciatica.' Consultation was made with two experienced orthopedic surgeons. The immediate attending surgeon definitely ruled lime deposits in the lower lumbar region as the cause of the sciatica. Both surgeons agreed that the thing to do was to provide boards under the mattress and to apply some form of deep heat. The deep heat treatment could be met by the application of hot, damp cloths or by diathermy.
>
> "The latter was chosen, and the diathermy was accompanied by vigorous massage and also by the use of electrically-activated plates applied simultaneously for a few minutes to the buttocks. The deep heat treatment lasted usually from 30 to 40 minutes, the massage five to ten minutes, and was carried out at first for three times a week and later only twice a week. This program was carried on for three months—May, June and July. To walk in an erect position was possible, but only with the greatest pain. This pain was relieved when a decided stooped position was taken. This indicated that a definite widening of the area between certain vertebra was instrumental in relieving the pressure upon certain nerves. The treatment

measurably improved the condition, but progress was slow.

"Harking back to the early experiments with animals and the possibility of moving calcium salts already deposited, I decided to make myself an experimental guinea pig. Instead of using hydrochloride I decided to use ammonium chloride, the reason being that a larger quantity of chlorine could be ingested with greater ease than an equivalent amount of chlorine as hydrochloride. . . . Four grams of ammonium chloride were taken daily—two after the morning meal and two after the evening dinner. The ammonium chloride was taken as a water solution but could be taken in capsule or as a pill. Nausea may be experienced if taken on an empty stomach.

"I followed this treatment for three weeks, but at the same time I received the diathermy-massage treatment. At the end of three weeks walking was again normal, the pain had left, and there has been no recurrence of the trouble. Treatments of all kinds were terminated in August 1950. The only modification made in the diet was a drastic reduction in the milk consumed. I generally consumed 1-1¼ quarts of milk daily. This was reduced to ½ quart and thereby reduced sharply the amount of calcium intake. No other changes in the diet were made. Unfortunately no determinations of calcium in the blood were made. . . .

"My own experience in the described treatment is complicated by the constant use of diathermy and massage, and one cannot be positive that the ammonium chloride was the actual critical factor in the remedial processes. Nevertheless, progress was most rapid in the three weeks when ammonium chloride was used.

"However, reports of three other cases, where no diathermy or massage was used are available. Two were men and one a woman—all suffered from what the physician called an arthritic condition and in one case an enlarged joint of the index finger accompanied the trouble. This enlargement, as well as the arthritic condition, disappeared on treatment with ammonium chloride.

"These have all been encouraging reports on a pathology that has not been rationalized into a definite therapy. It would seem that when the orthopedic surgeon, with his x-rays, definitely concludes that lime deposits have formed between the vertebra and their removal is indicated that an acid diet could be called into use. The way to do this has been described. At least it is worth a trial.

"This experience is recorded only for the purpose of stimulating research on a pathology of the aging. Backaches are common, but not all come from lime deposits. If there are extraneous lime deposits, then a rational therapy should be followed. The problem needs more study, more experience, and more cases to decide finally the validity and value of the suggested therapy."

We cannot leave the subject of Professor Hart's contributions without mention of something that has a bearing on the extent that he could add to our scientific knowledge. His department grew much more rapidly than the university as a whole. He established a large department that is well suited to tackling the problems of the future, but he took no credit for this development. In his typical and genuine modesty he said, "Wisconsin has been good to me and I have been fortunate in being here during a period when it has been possible to expand. The least I can do is to see that the expansion is on a sound basis." The impact of this organization will reflect for many years to come the efforts of a man who was its guiding genius for a period of 45 years. It may be said that E. B. Hart's impact on human nutrition should not be thought of in terms of studies which he made on human subjects, but in terms of his contributions to the science of nutrition, his teachings based on a careful screening of the facts as they were developed, and the establishment of a well-organized and active department which will continue probing into the unknown in the science of nutrition.

E. B. Hart's Contributions to Food Technology

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When Edwin B. Hart returned to Geneva from Albrecht Kossel's laboratory at Heidelberg, he began, with L. L. Van Slyke, a study of the changes in proteins in cheese during its ripening or curing. It was only a decade previous that dairying underwent a great change because of three factors: the invention of the mechanical cream separator, the perfection of the Babcock test, and the development of mechanical refrigeration. These advanced dairying from farm production to factory operation. The production of factory made butter and cheese increased tremendously in both New York and Wisconsin at the turn of the century.

CONTRIBUTIONS TO THE GROWTH OF THE DAIRY INDUSTRY

Hart and Van Slyke applied their methods of protein analysis, particularly the measure of water, salt and alcohol soluble fractions to characterization of the sequence of changes occurring in cheese during its curing. They established the relative solubilizing effects on casein of the enzymes originally present in milk, such as proteinase ("galactase"), of those from the growth of organisms, and of that added in the form of rennet. This led to an examination of the state or form of casein, and of its derivatives when milk is subjected to the action of

added rennin and developed acid such as occur in the cheese making process. A test commonly used then by cheese makers for gauging the making process was known as the hot-iron test. The character of the strings that formed when the curd was touched to a hot iron and pulled was indicative of potential appearance, plasticity, texture and curing properties of the cheese. The changes in the stretch or strings in the hot-iron index was attributed by Hart to the mono acid salt derivative of para casein; and that, in ripening, the solubilization of nitrogen compounds began not with para casein as commonly believed, but with the unsaturated para casein lactate. With developed methods of fractionation, Hart and Van Slyke identified and established the relative amounts of the prominent amino acid fractions which distinguished young and aged American cheese. By use of the protein fractionation analysis technique, the origin of carbon dioxide in the ripening of cheese was related to lactose in the early stage, and to degradation of amino acids such as tyrosine and arginine in subsequent fermentation. This observation was extremely important to the successful canning of natural cheese several decades later when special gas-escape containers for canned cheese were developed. It was at this time that Hart clarified the essential conditions of acidity under which added rennin was active in the formation of para casein lactate, and in differentiating the importance of the several factors of time, temperature, moisture, salt, rennet, acid and size in the protein degradation and ripening of cheese. These observations led to improved control of the cheese making process and to greater uniformity in quality of the cheese. They were also the basis for the subsequently developed and currently used long-time cold-curing and more recently, fast-ripening processes for cheddar cheese. Subsequently with Sammis, Hastings and Alice Evans, Hart studied the sequence of microbiological growth and protein degradation in cheddar cheese during its making and curing. The knowledge and experience thus established was very important to the early development of Wisconsin's cheese industry.

Very shortly after the culmination of these studies which occurred about the time of the introduction of commercially pasteurized bottled fluid milk, Hart proposed and urged the pasteurization of milk for cheddar cheese making for reasons of greater uniformity in quality of product. Some 30 years elapsed before this was generally adopted.

Although Hart had expended many years in following the protein changes during cheese curing, he concluded rather early that amino acids and proteid forms were not wholly responsible for cheese flavor. He established that a good portion of the flavor was due to hydrolytic products of fat, a form of research continued to this time with many varieties of cheese other than cheddar. It was during this time that he developed methods for the quantitative estimation of lactic acid in milk, and of its isolation from cheese in the presence of other acids.

STUDIES ON THE PROPERTIES OF SALTS IN CASEIN

It was through the studies on the forms of protein occurring in various stages of cheese ripening that Hart established the identity of the forms of casein occurring in the presence of added rennin, and salts, particularly of calcium. This knowledge of the properties of the salts of casein became very important, subsequently, as much of the butter in the early 1900's was produced from sour or acid cream; a defect of mottling of color was quite common. Hart showed that calcium caseinate of buttermilk serum was normally very finely dispersed. When subjected to the concentrations of brine normal in the salting of butter, the dispersed protein concentrated to more readily visible masses. Hart's practical remedy for the mottling defect was uniform distribution and controlled levels of salting of the butter, and more especially thorough washing of the freshly churned unworked butter granules to reduce protein concentration, a practice now almost automatic to the current generation.

Nearly fifteen years later knowledge of the properties of the salts of casein became the means of the control of the widespread and spasmodic problem of coagulation of canned evaporated milk during its heat processing. The coagulation of evaporated milk upon sterilization caused tremendous losses in the industry; much was subject to discard, and much had to be agitated to break down the developed coagulum. Variations in viscosity were tremendous. It was established by Hart, and his student H. H. Sommer, that the electrolytes directly affect the stability of milk during the application of heat. The addition of concentrates of milk serum, or of oxalate salt accentuated or prevented, respectively, the coagulation of milk in sealed vials heated in high temperature vapor baths, a new technique of laboratory sterilization. Under the conditions of heat processing, casein was found most stable when combined with a definite amount of calcium; at other ratios it became unstable and coagulated. Hart and Sommer found the stability of the calcium caseinate could be modified by the use of sodium phosphate or citrate ions which balanced the effect of the calcium in gram equivalent amounts. A major portion of all evaporated milk is today successfully processed by adjustment of the salts for control of viscosity, and coagulation.

The extended knowledge of the properties of the casein salts, and their behavior under various conditions of processing, has become extremely important in explaining various phenomena such as creaming properties of milk, developed viscosity in cream, emulsification and bodying in process cheese, and related effects. The behavior of the electrolytes in these reactions initially prescribed by Hart and Sommer have come generally to be known as "salt balance" effects.

The great difference in behavior of milk from individual cows to the "salt balance" effects stimulated many studies on the feeding of various materials to cows. This involved use of strong acids, various minerals, feeds and specific metal salts. Hart was always conscious of potential effects of such practices on other qualities of milk or milk products. It is not generally remembered that the first isolation and quantitative evaluation of citric acid in milk was achieved by Sommer and Hart.

It is interesting to note that during his association with Van Slyke, Hart had formed firm individual opinions about the necessity for accounting for the

principal components, fat, and casein in milk, so that its value for cheese making could be properly established. Babcock earlier had prudently observed that the yield of cheese, per pound of fat, was not as great when made from a rich milk, as when made from a lower test milk. Van Slyke and Hart had accumulated much data on the fat and casein contents of milk. Van Slyke adopted, though recognizing the variances, the general rule of increase of 0.4 pound casein for each percentage of fat above 3 as a basis of evaluating such milk. Hart, however, deemed it essential that the casein content of each lot of milk used for cheese be known. He developed a volumetric method for measure of casein centrifugally separated from extracted milk. This became known as the Hart casein test. Its application is limited primarily by lack of convenience. Hart's recognition at that time of the necessity for a means of accurately measuring the casein content of milk, and its economical value at the cheese factory stands out in stark reality today. The need for a rapid test for nonfat solids of milk is even greater today, not only for cheese making, but for more modern products such as nonfat dry milk, cottage cheese, and condensed or evaporated skimmilk. A more convenient precise test for either casein, or milk solids not fat, has not been developed in the long interim. A number of reviews, bulletins, and much research is current in the exploration of the problem, or on how to calculate the worth of milk for processing.

Much of Hart's research in the early years dealt with the protein chemistry of milk, and cheese ripening. In subsequent years he retained his interest in the technology of the rapidly developing dairy industry through aspects of nutrition; on the effects of rations given cows on the behavior, and on the nutritive properties of milk, on vitamin and mineral fortification of milk, and on nutritional properties of butterfat. His wonderful abilities as a teacher certainly inspired his co-workers and students, for they wrote the outstanding textbooks of the day on the technology of the manufacture of cheese, fluid milk products, and ice cream.

Acknowledgment

These papers in tribute to Edwin Bret Hart were presented at the Fourteenth Annual Meeting of IFT, June 29, 1954, Los Angeles, California. For his contributions to planning the tribute, to leading the Symposium, and to collating the papers for publication, appreciation is expressed to Dr. L. E. Clifcorn, Director, Research Department, Continental Can Company, Chicago.

Starchy Cereal Thickening Agents for Canned Food Products[a]

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Pastes made from waxy cereal thickenings and from mixtures of waxy and non-waxy thickenings show much less tendency toward liquid separation and setting up during storage than do pastes made from non-waxy thickenings alone. The substitution of waxy thickenings for all or part of the non-waxy thickening can eliminate some of the problems encountered in thickened canned food products.

The use of starchy thickening agents in canned food products results in various problems, the most serious of which are increasing gelation during storage ("setting up"), syneresis, and curdling. The recent discovery in this laboratory that waxy (glutinous) rice flour would greatly increase the stability of frozen sauces and gravies *(1)* led to the work reported here on cereal thickening agents for use in products subject to heat processing. The results obtained show that, to a considerable degree, glutinous or waxy-cereal thickening agents can stabilize the consistency of thickened materials following heat processing and storage.

The term "consistency" as applied to food products has been used to describe phenomena varying from Newtonian viscosity of syrups to elasticity of gels. In general, however, the object of a determination of "consistency" is to find how much or how little a product will deform or flow under normal conditions of use.

Numerous methods have been developed for the measurement of consistency. From the practical point of view, the simplest and most satisfactory is the "line spread" method or a modification such as the Bostwick consistometer wherein the distance traveled by a measured amount of material in a specified time interval is taken as the measure of consistency.

Such a measure is obviously a summation of all factors contributing to resistance to flow. If, for the sake of simplicity, these factors are classified as frictional and structural and a means is found for separately determining the two types of resistance to flow independently, then it would become possible to determine the manner in which a particular thickening agent contributes to the consistency of a product.

The methods used for this study were chosen with this object in mind and while it cannot be claimed that a complete separation of the frictional and structural components has been achieved, the degree of separation is large and the information obtained is of considerable value in showing the comparative characteristics of the thickening agents studied. The results reported here are principally those obtained from thickened autoclaved pastes. Results from a series of thickened pureed carrot soups are also given to show the effects of thickenings in a representative commercial preparation.

EXPERIMENTAL

Materials and methods. The thickening agents used were: (a) wheat flour, commercially prepared "all purpose" blend, (b) cornstarch, good commercial food grade, (c) waxy cornstarch,

[a] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, June 29, 1954.

commercial food grade,[b] (d) waxy rice flour, commercial food grade, (e) waxy sorghum flour, laboratory preparation, (f) waxy corn flour, laboratory preparation.

Paste preparation. Pastes were prepared in batches consisting of 4,000 g. of thickening agent and water plus 40 g. of sodium chloride. The amount of thickening agent was varied from 160 g. to 320 g. (4% to 8%) and the amount of water adjusted accordingly. The thickening agent, salt, and approximately 800 ml. of water were shaken in a closed container to form a smooth suspension, the remainder of the water was stirred in and the mixture was cooked, with constant stirring in an open steam-jacketed kettle for 5 minutes after reaching the boiling point. Preliminary experiments showed the cooking loss to be quite close to 100 g., and this additional amount of water was added before cooking; thus an attempt to distribute it uniformly in the paste after cooking was avoided.

The cooked paste was filled as quickly as possible into 211 x 300 (8 Z short) plain tin cans to within ¼ inch of the top (ca. 200 g.). The cans were then sealed and autoclaved in 15 psig. steam for 1 hour (121.1° C.). After autoclaving they were cooled and stored at room temperature (25° C. average).

Preparation of thickened carrot soup. The thickened carrot soups or infant foods were made up in 10-kg. batches according to a formula which was a simplified version of a commercial preparation. They contained 37.6% carrot puree, 3.1% tomato puree, 0.65% salt and thickening in the amounts shown in Table 2 plus water to a total of 100%. Potato puree (7.7%) was also used in one preparation and the amount of water reduced to compensate.

Carrots and potatoes were peeled, cooked in steam at 121.1° C. and ground through the ¼-inch plate of a Hobart food chopper. The thickening, salt, and water were made into a cooked paste in a manner similar to that described above. All ingredients were then combined and blended in a Hobart mechanical mixer. The mixture was put through a paddle finisher with a 0.045-inch screen and then boiled for 20 minutes to remove the considerable amount of air incorporated during the finishing operation. Water equivalent to the evaporation loss was added and carefully mixed in. The material was hot filled into 211 x 300 cans, sealed, autoclaved 45 minutes at 250° F., and stored at room temperature.

Measurement of gelation. The method used for the measurement of gelation was essentially that proposed by Owens, Porter, and Maclay *(2)* for the determination of the modulus of rigidity of pectin gels. The method was modified and refined considerably both for convenience and because of the much smaller amount of gelation with which we were concerned. Figure 1 shows the apparatus used and the essential features. Twenty-four-inch lengths of wire were used. The greater part of the determinations were made with a wire 0.014-inch in diameter with a torsional moment of 2.18 g. cm. Wires of 0.008- and 0.019-inch diameter with torsional moments of 0.238 g. cm. and 0.631 g. cm., respectively, were also used on occasion.

None of the pastes studied had characteristics approaching those of the perfectly elastic body. Plastic flow occurred in all cases, but to a much greater degree in some preparations than in others. For this reason an empirical method of correction for plastic flow was developed. The principal justification for the correction method is that when it is applied to measurements made on highly viscous supersaturated dextrose solutions, no elasticity is found within the limits of experimental error.

A 1 x 5-cm. blade was calibrated against a cylinder *(2)* and used to make a series of 8 measurements on each paste. These measurements were alternated on each side of a center line with the angular displacement of the upper wire suspension increasing from about 1 degree for the first to 5 degrees for the eighth.

Figure 2 shows a typical series of displacements as recorded by the optical lever and camera. The outer trace records the displacement of the torsion head (W) and the inner trace records the displacement of the blade (w). The interval between displacements is 10 seconds. As can be seen from these traces, there is some displacement of the blade after displacement from the center line has stopped and also, that the blade trace does not return to the center line when the reference line does. This effect can be called slippage, plastic flow, or stress relaxa-

[b] The sample of waxy corn starch used had been stored for considerable time so that its thickening properties were not as good as could be expected from a good commercial preparation.

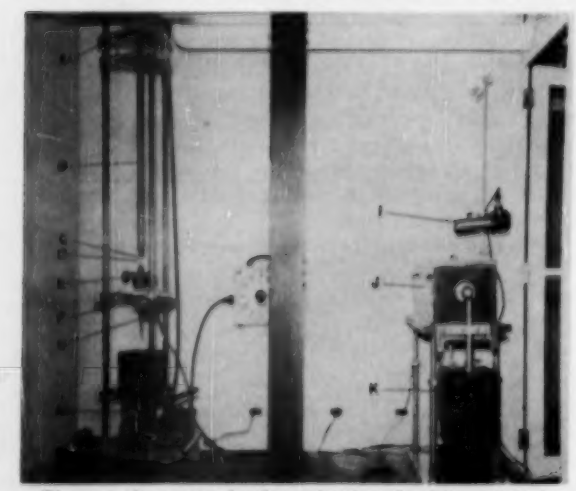

Figure 1. Apparatus for determination of gel strength (glass doors removed for photograph): A, motor-driven torsion head, B, tube enclosing torsion wire driven by torsion head, C and D, mirrors reflecting displacement of torsion head and blade, respectively. E, magnetic oscillation damper. F, blade shaft clamp. G, weight and 1 x 5-cm. blade. H, sample-elevating mechanism. I, optical lever light source. J, camera with 16 x 20-in. photographic paper on drum. K, variable-speed camera drum drive.

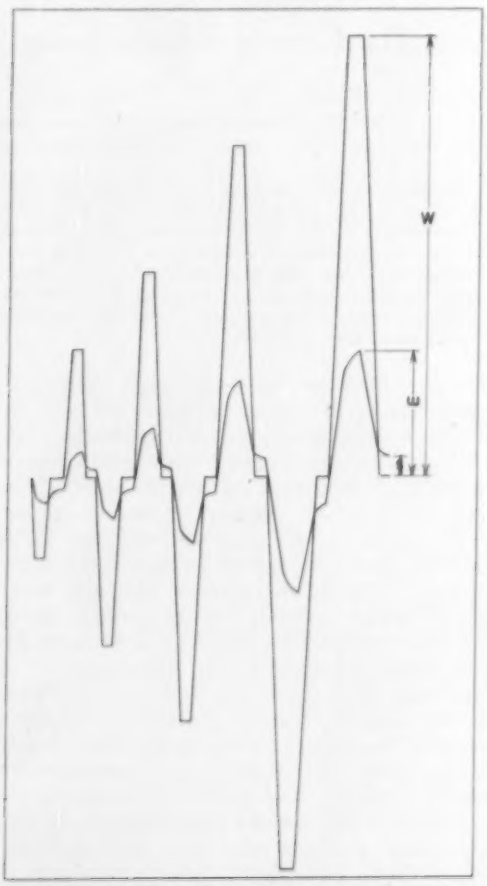

Figure 2. Recording of gel strength determination. Symbols show measurements used for calculation and correction. W, displacement of torsion head. w, displacement of blade. S, slippage measurement used in corrections.

tion and represents a departure from true elasticity. The following is the expression for the empirical correction for slippage, which was used in the calculation of the results presented here:

$$\delta \text{ cor} = \delta_o - S\frac{W}{w}$$

where: δ cor is the angle between torsion head and blade corrected for slip; δ_o is observed angle (W-w); S is angle between torsion head and blade after torsion head is returned to starting point; W is angular displacement of torsion head from starting point; and w is angular displacement of blade from starting point.

Viscosity. Because of the anomalous flow characteristics of these materials, no attempt was made to determine a true viscosity. Apparent viscosity determinations were made with the Model LVF Brookfield Viscometer. A speed of 30 r.p.m. was used throughout, but it was necessary to change spindles to cover the range of apparent viscosities encountered. While the different spindles have different diameters and consequently different rates of shear at constant angular velocity, it was found by checking numerous suitable samples that the spindles were essentially interchangeable, whereas a change of spindle speed gave a considerable change of apparent viscosity.

Following the gel-strength determination, the pastes were transferred to beakers and heated to approximately 90° C. on a steam bath to remove as much of the gelation as possible. The samples were then placed on the viscometer and allowed to cool in air to 75° C., at which temperature an apparent viscosity reading was taken. The samples were then cooled to 25° C. in a constant-temperature water bath and another reading taken. While cooling, the samples were stirred with a low-speed mechanical stirrer to prevent the reformation of the gel structure. While apparent viscosity readings were taken, temperatures were measured with a copper-constantan thermocouple junction placed as closely as possible to the spindle without interfering with its action.

Consistency. The Bostwick consistometer was used to determine the consistency of the thickened carrot-soup preparations. In this instrument, the measure of consistency is the distance in centimeters over which a measured amount of material will flow in 5 seconds in a level trough 5 cm. wide. The values are therefore inversely proportional to the stiffness of the preparation. Since some of the preparations became too stiff to show appreciable flow, the results obtained were only moderately useful.

Appearance and syneresis. Texture (whether smooth or lumpy), paste character (long or short), and amount of free liquid were noted when the samples were opened. Since the free liquid could not be separated from some of the samples for measurement, it was graded as 0 for no liquid, + for very slight amount, ++ for a few drops, +++ for a continuous layer, and ++++ for ⅛ inch or more.

No attempt was made to adjust or control the pH of the preparations used. The effect of various buffer ions on the viscosity and gelation of starch material is so great as to obscure the characteristics in which we were most interested.

RESULTS AND DISCUSSION

Results obtained from this investigation are grouped to show the properties of the pastes made from individual thickenings (Table 1, part A) and of pastes made from mixtures of thickenings (Table 1, parts B and C). The thickened carrot soup was chosen as a representative of products of practical interest to show the applicability of the findings to such a product (Table 2).

In a descriptive sense, the viscosities encountered in these preparations range from a very thin sauce to a moderately thick pudding. Gelation is barely perceptible at low values below 0.05 g./cm.^{2} and none of the pastes investigated was self-supporting, although elasticity was obvious in most of them. The carrot soups made with wheat flour and cornstarch were not self-supporting initially but became so with storage. Because of such factors as stress relaxation or plastic flow, there is no fixed value at which such preparations as these could be said to become self-supporting.

The effect of storage on the characteristics of the pastes made from different thickening agents varies widely (Table 1, part A). With the exception of the 7% wheat-flour paste, the initial gelation of these pastes was low but the gelation of the wheat flour and cornstarch pastes increased markedly with storage while those made from the waxy thickenings showed no significant change.

The apparent viscosities of these pastes, with the exception of the waxy cornstarch paste, show little or no change during storage. The decrease in apparent viscosity of the waxy cornstarch pastes is sufficient after 90 days' storage to be readily noticeable.

The temperature at which a product is generally consumed might influence the choice of thickening agent. However, the proportion of difference between apparent viscosities measured at 25° C. and 75° C. was similar in all the thickenings tested with the exception of waxy cornstarch, which showed practically no difference.

The syneresis that developed with pastes from the non-waxy thickening agents was different from that which developed with the waxy thickenings, in that the gel structure was shrunken and liquid was present around the edges as well as on top. With the waxy thickenings the liquid separation, when present, seemed to be due more to settling than to shrinkage.

Waxy rice flour prevents gelation during storage when it comprises only a part of the thickening (Table 1, part B). Its effect in this series of experiments is particularly interesting. These results show that as the total concentration of thickening agent increases, the proportion of waxy rice flour required to prevent increase of gelation during storage also increases. Since amylose is the principal gel-forming component of the paste, this effect could be the result of reducing the concentration of amylose below the amount necessary to form a gel. However, as these results show, the effect is somewhat greater than can be accounted for in this manner alone. Increase of gelation during storage is prevented at 5% total thickening when 28% of the thickening is waxy rice flour and 0.7% amylose is present; at 8% total thickening, it is prevented by 38% waxy rice flour even though 1% amylose is present. Since at 8% total thickening, it would require 54% waxy rice to reduce the amylose to 0.7% it is apparent that the effect of waxy rice flour is not due only to dilution of amylose, but also to interference with gel formation. It should also be noted that in these pastes where gelation does not increase, the amount of gelation is low.

Since the results in Part A showed that the viscosity of these pastes had little tendency to change during storage, the viscosity was followed in only a few pastes in Part B and confirmed the lack of change found in the earlier experiments. The viscosity data show that the substitution of waxy rice flour for wheat flour has little effect on apparent viscosity.

The tendency toward liquid separation during storage decreases as the proportion of waxy rice flour increases

TABLE 1

Effect of storage on characteristics of thickened pastes

A. Single Component Pastes

Total conc.	Percent of total [2]	Amylose [1]	Gelation (g./cm.²) Days Storage at 25° C. 1-2	3-10	11-30	31-60	61-120	120-200	Viscosity (Poises) ° C.	10	30	90	Syneresis 10	30	90
%		%													
5	100 WF	1.0	0.02	0.03	0.05	0.04	0.08		25	7.3	7.7	7.3	–	+	++
									75	5.9	6.0	6.9			
6	100 WF	1.2	0.09	0.15	0.18	0.21	0.21		25	12.5			+	+	+
									75	7.5					
7	100 WF	1.4	0.21	0.22	0.27	0.27	0.35		25	17.2	17.3	17.6	+	+	+
									75	11.3	10.9	11.2			
4	100 CS	1.0	0.03	0.05	0.06	.....	0.08	0.18	25	9.5	8.9	10.0	–	–	++
									75	7.1	7.0	6.6			
5	100 CS	1.3	0.04	0.07	0.11	0.16			25	11.1	14.1	12.8	–	+	+
									75	10.8	9.6	7.5			
5	100 WRF	0.0	0.05	0.04	0.05	0.04	0.02		25	7.5	6.9	6.0	–	–	+[3]
									75	5.2	4.8	3.7			
7	100 WRF	0.0	0.03	0.03	0.03	0.03	0.03		25	16.1	15.2	16.2	–	–	–
									75	11.1	9.7	9.5			
8	100 WCS	0.0	0.00	0.00	0.00	0.00	0.00		25	0.9	0.7	0.4	–	–	–
									75	1.1	0.5	0.3			
7	100 WCS	0.0	0.01	0.01	0.01	0.01	0.01		25	13.8	10.9	5.7	–	–	+
									75	13.3	9.2	5.3			
7	100 WCF	0.0	0.03	0.03	0.03	0.04	0.03	0.04	25	10.8	10.3	9.0	+	+	+
									75	4.8	4.5	4.6			
7	100 WSF	0.0	0.01	0.01	0.02		0.02		25	11.1		10.3	–	–	–
									75	6.2		6.0			

B. Mixtures of Wheat Flour and Waxy Rice Flour

	WF	WRF													
5	100	0	1.0	0.02	0.03	0.05	0.04	0.08		7.3	7.7	7.3	–	+	+
5	83	17	0.8	0.03	0.04	0.05	0.06	0.08		5.1			–	+	++
5	77	23	0.8	0.03	0.04	0.04	0.05	0.06		6.8			+	+	+
5	72	28	0.7	0.04	0.04	0.05	0.05	0.05		6.7			–	–	+
5	67	33	0.7	0.04	0.04	0.04	0.04	0.05		6.7			–	–	+
5	62	38	0.6	0.04	0.04	0.04	0.05	0.05		7.4			–	–	+
6	100	0	1.2	0.09	0.15	0.18	0.21	0.21		12.5			+	+	+
6	83	17	1.0	0.04	0.06	0.07	0.09	0.10		12.0	11.6	11.8	–	–	+
6	77	23	0.9	0.05	0.08	0.09	0.11	0.10		12.0			–	–	–
6	72	28	0.9	0.05	0.06	0.07	0.08	0.08		11.0			–	–	–
6	67	33	0.8	0.05	0.06	0.07	0.06	0.07		11.4			–	–	–
6	62	38	0.7	0.05	0.06	0.06	0.06	0.06		11.6			–	–	–
7	100	0	1.4	0.21	0.22	0.27	0.27	0.35		17.2	17.3	17.6	+	+	+
7	83	17	1.2	0.12	0.19	0.21	0.20	0.20		17.6			+	+	+
7	77	23	1.1	0.11	0.16	0.20	0.19	0.23		19.5			–	–	–
7	72	28	1.0	0.08	0.11	0.13	0.15	0.15		19.7	19.4	19.3	–	–	+
7	67	33	1.0	0.08	0.10	0.12	0.12	0.11		18.4			–	–	–
7	62	38	0.9	0.07	0.07	0.08	0.08	0.08		18.5			–	–	–
8	83	17	1.3	0.31	0.35	0.40	0.39	0.49		29.9			–	–	+
8	77	23	1.2	0.20	0.24	0.30	0.30	0.30		28.2			–	–	–
8	72	28	1.2	0.18	0.20	0.24	0.24	0.25		27.2			–	–	–
8	67	33	1.1	0.12	0.14	0.15	0.17	0.19		23.5			–	–	–
8	62	38	1.0	0.07	0.08	0.08	0.08			22.3	20.7		–	–	–

C. Other Binary Mixtures

5	53 CS	47 WRF	0.5	0.04	0.04	0.03	0.03	0.02	0.03	10.7	7.7	6.7	–	+	++
5	53 CS	47 WCS	0.5	0.02	0.02	0.02	0.01	0.01	0.02	5.9	4.5	4.3	–	+	++
6	22 CS	78 WRF	0.3	0.05	0.04	0.04	0.03	0.03		12.7	11.4	11.3	–	+	++
6	22 CS	78 WCS	0.3	0.01	0.01	0.01	0.01	0.01	0.01	10.4	5.1	4.2	–	–	+
5.7	59 WF	41 WCS	0.7	0.02	0.02	0.02	0.03	0.03	0.03	8.8	8.3	8.8	–	–	–
6.3	26 WF	74 WCS	0.3	0.01	0.01	0.01	0.01	0.01	0.01	7.7	7.6	8.0	–	–	–
5.3	59 WF	41 WCF	0.7	0.02	0.03	0.03	0.03	0.04	0.06	6.8	6.6	6.5	–	+	+++
6	83 WF	17 WCF	1.0	0.03	0.04	0.05	0.06	0.07	0.07	7.7	8.2	8.4	+	++	+++
8	62 WF	38 WCF	1.0	0.04	0.06	0.06	0.09	0.09	0.13	16.4	17.0	17.4	–	+	++
5.7	59 WF	41 WSF	0.7	0.01	0.02	0.03	0.03	0.03		6.5	7.0	6.4	–	–	++
6	83 WF	17 WSF	1.0	0.03	0.04	0.05	0.05	0.06	0.06	8.0	8.2	8.5	+	++	++
8	62 WF	38 WSF	1.0	0.07	0.09	0.11	0.08	0.10		20.0	19.8	19.5	–	–	–

[1] Estimated.
[2] WF, wheat flour; CS, cornstarch; WRF, waxy rice flour; WCS, waxy corn starch; WCF, waxy corn flour; WSF, waxy sorghum flour.
[3] Settling rather than gel shrinkage.

TABLE 2

Effect of storage on characteristics of thickened carrot soups

Total conc.	Percent of total	Conc. Amylose	Gelation						Viscosity			Bostwick AH			Syneresis		
			Days Storage at 25° C.														
			1-2	3-10	11-30	31-60	61-120	120-200	10	30	90	10	30	90	10	30	90
5.7	100 WF	1.1	1.3	1.3	1.6	1.5	2.5	3.7	36.6	38.5	37.3	4.9	3.7	2.7	+	+	++
7.2	100 WRF	0.0	0.2	0.2	0.2	0.2	0.2	0.2	34.0	35.5	38.8	8.4	8.1	8.0	–	–	–
4.5	100 CS	0.9	1.0	1.2	1.6	1.8	2.8	6.8	35.4	40.0	34.8	1.8	1.4	0.9	+	+	++
7.9	100 WCS	0.0	0.01	0.01	0.01	0.01	0.01	0.01	9.5	10.4	9.7	13.3	12.0	10.7	–	–	–
4.5	100 WF + potato	1.1	3.6	3.9	4.5	5.3	7.3	10.1	56.4	60.0	63.0	2.3	1.6	0.8	+	++	+++
5.7	100 WF	1.1	2.3	2.6	3.1	3.7			–	–	–	–	4.2	4.2	–	–	+
6.5	59 WF 41 WRF	0.8	2.4	2.3	2.3	2.3			–	–	–	–	4.0	4.3	–	–	–
8	100 WRF	0.0	1.8	1.6	1.8	1.8			–	–	–	–	4.5	4.9	–	–	–

and, as would be expected, also decreases as the total concentration of thickening increases.

Pastes made from other mixtures of non-waxy and waxy cereal thickenings confirm the stabilizing effect of waxy cereals on gelation and show the differences of effectiveness of the waxy cereals (Table 1, part C).

The effect of storage on the properties of thickened carrot soups (Table 2) is similar to that for the pastes. This would indicate that, in many cases, the information on the characteristics of these pastes could serve as a guide in the selection of thickenings for various food products. The thickening properties of the other constituents should, of course, be taken into consideration. In this case, while the carrot puree has markedly increased both gelation and apparent viscosity, the effect of the thickening agents is still clearly apparent. In other cases, it is possible that the thickening properties of the other components could overshadow the effects of the thickening agent.

Waxy rice flour was effective in preventing setting up and syneresis in these soup preparations as it was in the pastes. The two lots of soup thickened with wheat flour differed only in that the carrots used in the first lot came from cold storage and those used in the second lot were fresh. The difference of gelation and consistency illustrate the difficulty of maintaining a uniform product made from materials which are not uniform. In the carrot soup, which also contained potato, the amount of wheat flour was reduced to compensate for the amount of starch estimated to be present in the potato. This preparation showed considerably more gelation and liquid separation than any of the other soups.

The gelation and apparent viscosity of the soups thickened with wheat flour and corn starch were quite similar up to 120 days of storage, but the consistency as determined with the Bostwick consistometer shows considerable difference. Although it is possible that this is indicative of some component of consistency other than gelation and viscosity, it seems more likely that it is due to the greater sensitivity of the Bostwick method in this range.

Paste character is an important property of a thickened product that is not readily evaluated except by inspection. The pastes made from wheat flour, cornstarch, and waxy rice flour were "short" or non-stringy. Waxy corn flour was slightly less "short" and the waxy cornstarch and waxy sorghum flour pastes were "long." The pastes made from waxy corn flour and waxy sorghum flour each had rather strong characteristic odors which might not be acceptable in some products.

From the results presented here it is evident that a considerable degree of control over the consistency of thickened food products is possible by the choice of appropriate thickening agents or combinations of thickening agents. Thus, viscosity may be adjusted by adjusting the total amount of thickening, and gelation may be controlled by increasing or reducing the proportion of waxy cereal thickening agent. Syneresis and setting up may be reduced by the use of waxy cereal thickenings, but at the expense of reducing gelation which in some cases might not be desirable.

SUMMARY

The properties of pastes made from wheat flour, cornstarch, waxy rice flour, waxy cornstarch, waxy corn flour, and waxy sorghum flour have been investigated with particular reference to the utility of these materials as thickening agents for canned food products. The results show that pastes made from the waxy cereal thickenings and from mixtures of nonwaxy and waxy thickenings are considerably more stable during storage than pastes made from wheat flour or cornstarch alone. The effect of storage on the properties of a series of thickened carrot soups indicates that the results obtained from the simple paste preparations are applicable to food products which do not contain large amounts of naturally occurring thickening materials.

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The Translocation of Sugars and Water in Canned Fruits[a,b]

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Drained weight of fruit and sirup cutout (Brix) are important quality factors in canned fruits which are determined by the translocations of sugars and water during storage after canning. These translocations were found to be dependent on both cover sirup type and type of fruit pack. It was proposed that diffusion properties of individual sugars in a particular fruit matrix were responsible for determining magnitude and direction of translocations. Only one of the five cover sirup variations studied showed distinctly different translocation effects in certain of the fruit packs.

Use of cover sirups as an adjunct to the canning of fruits continues to be commercial and home practice. The sugars in these sirups contribute sweetness, body, color stability, and various other desirable organoleptic qualities. Reflecting these qualities, and including others, are the drained weight of fruit and the sirup cutout (Brix). Since these two quality factors are included in the U. S. Standards for Grades of canned fruits, commercial canners are particularly concerned with the characteristics of sugars which influence them. Improved manufacturing practices within the past two decades bring to market a number of highly refined sugar and sirup products possessing characteristic physical and chemical properties *(4, 6, 7)*. How these properties affect drained weight of fruit and sirup cutout is important to manufacturers of the sugar and sirup ingredients, as well as to canners of fruit products. Thus, the question poised is a dual one: What are the effects of various sugars on these two quality factors and what is the mode of action of the sugars in causing the observed effects?

Wiegand *(9)* reported the effects of three sirup variations on drained weights of several canned fruits, during storage up to 210 days. His results as given for pears showed an initial, rapid decrease in drained weights, well below fill weights for all three sirup variations, immediately after canning. This was followed by a rapid increase in drained weights, which gradually leveled off above fill weights and remained nearly equal for the three sirup variations between 40 and 160 days of storage. Certain variations between sirup type effects were interpreted on the basis of a higher rate of absorption of dextrose than of sucrose by the fruit due to higher osmotic pressure.

The high initial osmotic pressures in cover sirups would no doubt cause a rapid translocation of water from fruit to sirup immediately after canning. It seems logical to assume that a translocation of sugar molecules from sirup to fruit would also occur, depending on the permeability of the fruit matrix. The diffusion rates of individual sugar molecules would be dependent upon their respective concentration gradients and diffusion coefficients, according to Fick's First Law of Diffusion *(3)*. Other factors which would influence diffusion are absolute concentration level, temperature, and flow of solvent *(2, 8)*.

The results obtained in this investigation furnish information about the relative movements of sugars and water in canned fruits as reflected in drained weight and Brix changes for 6 different fruit packs and 5 different sirup variations.

EXPERIMENTAL METHOD

Design of experiment. A *rate pack* was designed to show the changes with storage time in drained fruit weights and sirup cutouts for the 6 fruit and 5 sirup variations. For any one fruit variation, a pack consisted of separate batches of 12 cans, 2 cans for each of 6 sampling (cutting) times. A batch was a separate processing run wherein cans in the batch were exposed to simultaneous exhausting, cooking, and cooling operations. Two batches were run for each of the 5 sirup variations.

For a comparison between cover sirup treatments at one cutting time after prolonged storage (3 months), an *equilibrium pack* was prepared. This pack was composed of at least 6 batches for each fruit variation. A batch contained duplicate cans for each sirup variation, a total of 10 cans per batch.

Materials. The 6 fruit variations were Royal Ann, Bing, and Lambert cherries, pear (Bartlett) halves, peach (Elberta) halves, and sliced peaches. The cherries were canned whole, stemmed, and unpitted. All packs were in 401 x 411 cans, the light sweet cherries, peaches, and pears in plain tin and the dark sweet cherries in fruit enamel cans.

The 5 sirup variations were:

No. 1: Straight sucrose solids
No. 2: 2 parts sucrose solids + 1 part dextrose solids
No. 3: 3 parts sucrose solids + 1 part 42 D. E. CSU[c] solids
No. 4: 3 parts sucrose solids + 1 part 54 D. E. CSU solids
No. 5: 3 parts sucrose solids + 1 part 65 D. E. CSU solids

The Brix values of the fill sirups used were:

For Royal Ann cherries	40.0°
For Bing cherries	36.0°
For Lambert cherries	36.0°
For peach halves	52.0°
For peach slices	55.0°
For pear halves	40.0°

The finished packs were equivalent to Fancy Grade, Extra Heavy Sirup, as defined in U. S. Standards for Grades.

Procedures. The 5 cover sirups were prepared the day before canning and in sufficient quantities for a complete fruit run. Soluble solids as degrees Brix were determined by use of the Abbe refractometer, and were considered as an estimation of content of sugars. The sirups were stored overnight at 32° F. (0° C.). A number of random samples of raw fruit equal to the number of cans in each batch was taken for Brix and pH

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[b] Presented at the Fourteenth Annual Meeting of IFT, Los Angeles, California, July 1, 1954.

[c] Corn sirup. D. E. = dextrose equivalent as stated by the manufacturer (American Maize-Products Co.). Original products were 80.3° B, 81.1° B and 81.8° B of 42, 54 and 65 D. E., respectively.

determinations during preparation of the fruit for canning. Drained weights of fruit and of sirup after canning were determined after draining 2 minutes on a tilted 8-mesh screen as specified in U. S. D. A. grades. Fruit samples were prepared for pH and Brix determinations by use of the Waring blender.

The fruits were prepared for processing by hand in quantities for one batch at a time. Flow-operations were as follows:

Cherries:

Transported to Pullman same day as harvested
Stored overnight at 33° F. (0.5° C.)
Stemmed, dip and spray washed
Inspected, sorted, and drained
Filled, 540 g. fruit/can
Siruped, 325 g. sirup/can
Exhausted 9 minutes in steam at 180° F. (82° C.)
Sealed
Processed 20 minutes at 208°-210° F. (98°-99° C.) in boiling water
Cooled in water

Peaches (packs of halves and of slices were prepared and processed on different days as separate packs):

Transported to Pullman same day as harvested
Ripened at 90° F. (32° C.). Peaches for slices cold stored
Sorted for proper maturity
Halved on ringing knives
Steamed 20-30 seconds
Slip-peeled
Spray washed
(Halves pushed through grid for sliced peach pack)
Filled, 510 g. halves/can, 540 g. slices/can
Siruped, 345 g./can for halves, 340 g./can for slices
Exhausted 12 minutes in steam at 208° F. (98° C.)
Processed 18 minutes for halves, 15 minutes for slices, at 208°-210° F. (98°-99° C.) in boiling water
Cooled in water

Pears:

Transported to Pullman same day as obtained from commercial cold storage
Ripened at 62°-70° F. (17°-21° C.) for 4 days
Hand-peeled, cored and sliced
Brine (1%) dipped
Spray washed
Filled, 525 g. halves/can
Siruped, 340 g./can
Exhausted 10 minutes in steam at 208° F. (98° C.)
Processed 20 minutes at 208° F. (98° C.) in boiling water
Cooled in water

Cans were cut from the rate packs after 1-day, 3-day, 1-week, 3-week, 6-week, and 3-month storage periods at ambient room temperatures (70°-95° F.; 21°-35° C.). The equilibrium packs were sampled after a 3-month storage period for each of the fruit variations. Drained weights, Brix and pH were determined for the fruit and for the cover sirup.

RESULTS

Rate packs. Pertinent pH data are given in Table 1. The ranges of pH given clearly show the very small pH variations in any one fruit pack for all 5 sirup variations. In the case of the raw sirups, it was observed that the minimum pH values were for sirup No. 3, while the maximum values were for sirup No. 1. The others fell in between in the order of sirup Nos. 4, 5, and 2, respectively.

The rate pack results supplied information about the type and direction of *changes* which occurred in drained weights and soluble solids during storage. Since these changes appeared to be of the same general type for all fruit packs investigated, the sums of respective values for all fruits for each of the cutting times [4] were plotted as shown in Figures 1, 2, and 3, depicting graphically the over-all changes in drained weights of fruits,

[4] Totals of averages of values for 4 cans for 6 fruit variations for each cutting time.

TABLE 1

Ranges [1] of pH found for the raw and canned fruits and sirups

Samples	pH Ranges					
	Royal Anne cherries	Bing cherries	Lambert cherries	Peach halves	Peach slices	Pear halves
Fruit						
Raw	3.57-3.64	3.78-3.88	3.76-3.85	3.90-4.30	4.10-4.30	3.89-4.50
Canned:						
1-day	3.62-3.72	3.82-3.90	3.85-3.98	3.98-4.11	4.00-4.34	4.10-4.26
3-month	3.80-3.91	3.96-4.00	3.97-4.03	3.91-3.99	3.98-4.21	3.98-4.13
Sirup						
Raw	6.98-8.10	6.99-8.18	7.12-8.10	6.82-8.07	6.84-7.93	7.39-8.41
Canned:						
1-day	3.70-3.78	3.88-3.94	3.84-3.92	4.10-4.20	4.02-4.22	4.12-4.32
3-month	3.79-3.91	3.95-4.01	3.91-4.02	3.88-4.05	3.95-4.22	3.98-4.17

[1] Each range includes values for 20 cans or 20 raw samples for the 5 sirup variations.

sirup cutouts, and Brix of fruits. Drained sirup weights were not plotted, since they would merely illustrate mirror image curves of drained fruit weights. On the average, the changes in sirup cutouts (Figure 1) were the same type and nearly equal in magnitude for all sirup variations, a nearly constant level being attained after a rapid decrease during the first week's storage. The Brix of the fruits changed in similar manner (Figure 2) but in opposite direction, becoming nearly constant and equal to sirup cutouts, after a rapid increase during the first week's storage. For drained fruit weights (Figure 3), there were apparent differences between sirup type effects. The greatest initial

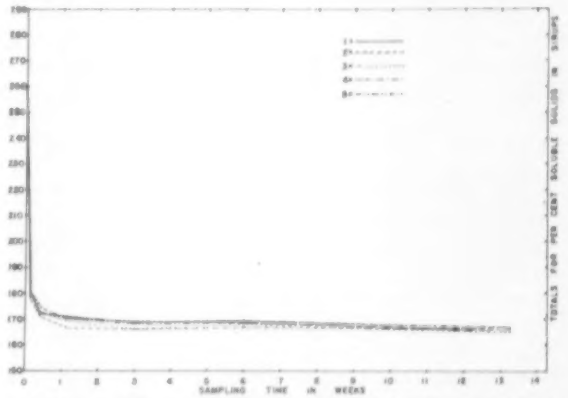

Figure 1. Changes in sirup cutouts (Brix) with storage time. Totals of averages for 6 canned fruit variations and cover sirup Nos. 1, 2, 3, 4, and 5.

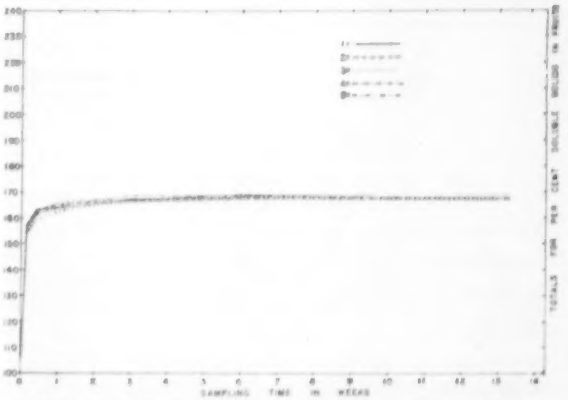

Figure 2. Changes in Brix of fruits with storage time. Totals of averages for 6 canned fruit variations and cover sirup Nos. 1, 2, 3, 4, and 5.

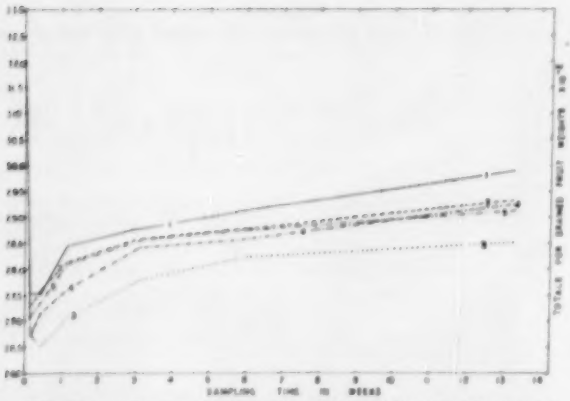

Figure 3. Changes in drained weights of fruits with storage time. Totals of averages for 6 canned fruit variations and cover sirup Nos. 1, 2, 3, 4, and 5.

shrinkage was evident for sirup No. 3 and the least for sirup No. 1. Sirup Nos. 2, 4, and 5 seemed to effect the same type and magnitude of changes of drained weights during storage. The separation of sirup No. 1 effects from these three was due to an exaggerated effect which happened in the case of the sliced peach pack but not in the others.

Although the general type of changes were similar in all fruit packs for all cover sirup variations, some noteworthy differences were observed between the cherry packs as a group and the peach and pear packs. The minimum drained fruit weights were reached sooner (at the 1-day cutting) for the peach and pear packs than for the cherry packs (at the 3-day and 1-week cuttings). The rate of increase in drained weights was much more rapid, at least up to the 6-weeks' cutting, for the peach and pear packs than for the cherry packs. Except possibly for sirup No. 3, as evidenced in Figure 3, there were no large and consistent differences in sirup type effects that were evident from plots of the changes for the individual fruit packs. Greatest differences were found in the magnitude of sirup type effects, both on drained weights and sirup cutouts, in the Lambert cherry pack.

Results from the rate pack study indicated that sirup cutouts had reached a constant level after 3 months' storage, but that further gradual increases in fruit drained weights would be expected if storage were continued beyond that time. Thus, the term "equilibrium pack" was not strictly accurate, but was considered sufficiently appropriate from a practical viewpoint.

To obtain a picture of the actual translocation of sugars and water in the canned fruits, the amounts of each present in fruit and sirup, respectively, were calculated from the average drained weights and Brix values at each of the cutting times. Fruit values were used to calculate amounts of sugars, sirup values for amounts of water. As a result, Figure 4 was plotted to show the changes of sugars contents of the fruits and water contents of the sirups.

Equilibrium pack. Mean values for fruit drained weights, sirup cutouts, and Brix of fruits for 6-8 replicated batches after 3 months' storage are given in Tables 2 and 3. The sirup cutouts and Brix of fruits (Table 2) were remarkably constant

TABLE 2

Fruit and sirup Brix means and their significance after 3 months' storage

Fruit pack	Fruit fill (°B)	Mean Brix (°B) of fruit — Sirup No. 1	2	3	4	5	N[1]	L. S. D.
Royal Ann cherries	19.5	28.3	27.8	28.0	28.2	27.7	6	.....
Bing cherries	27.0	30.8	30.9	31.0	30.9	31.2	8	.....
Lambert cherries	22.3	28.5	28.5	28.7	28.5	28.2	8	.....
Peach halves	12.0	28.5	28.1	28.4	28.3	28.2	8	.....
Peach slices	11.8	28.5	28.6	28.4	28.5	28.5	8	.....
Pear halves	13.6	23.9	23.9	23.9	24.0	23.9	6	.....
Fruit pack	**Sirup fill (°B)**	**Sirup cutout (°B) means — Sirup No. 1**	**2**	**3**	**4**	**5**	**N[1]**	**L. S. D.**
Royal Ann cherries	40.0	27.8	27.6	27.1	27.6	27.4	6	.....
Bing cherries	36.0	30.1	30.0	30.2	30.0	30.3	8	.....
Lambert cherries	36.0	28.3	28.3	28.1	28.2	28.0	8	.....
Peach halves	52.0	28.6	28.0	28.6	28.5	28.4	8	0.39[2]
Peach slices	55.0	28.6	28.4	28.6	28.4	28.4	8	.....
Pear halves	40.0	23.9	23.9	23.9	24.0	23.9	6	.....

[1] Number of batches (2 cans/sirup/batch).
[2] Least significant difference at the 1% level.

TABLE 3

Fruit drained weight means and their significance after 3 months' storage [1]

Fruit pack	Fruit fill (g.)	Mean drained weights (g.) — Sirup No. 1	2	3	4	5	N[2]	L. S. D.
Royal Ann cherries	540.0	457.6 (84.7)	454.7 (84.2)	447.3 (82.8)	450.1 (83.4)	452.9 (83.9)	6	6.17[3]
Bing cherries	540.0	493.0 (91.3)	492.3 (91.2)	482.7 (89.4)	489.2 (90.6)	491.2 (91.0)	8	6.13[4]
Lambert cherries	540.0	473.0 (87.6)	473.5 (87.7)	458.1 (84.8)	461.6 (85.5)	465.9 (86.3)	8	6.93[3]
Peach halves	510.0	481.8 (94.5)	485.6 (95.2)	476.3 (93.4)	475.9 (93.3)	481.6 (94.4)	8	7.41[3]
Peach slices	540.0	504.1 (93.4)	499.9 (92.6)	498.2 (92.3)	496.6 (92.0)	496.8 (92.0)	8	.....
Pear halves	525.0	495.2 (94.3)	496.8 (94.6)	499.8 (95.2)	494.9 (94.3)	497.7 (94.8)	6	.....

[1] Values in ( ) are % of fill weight.
[2] Number of batches (2 cans/sirup/batch).
[3] Least significant difference at the 1% level.
[4] Least significant difference at the 5% level.

within each fruit variation for the 5 cover sirup types. Although statistically significant differences were indicated for sirup cut-outs in the pack of peach halves, the greatest difference was only 0.6° B, and not likely of any practical significance.

Following a trend indicated by results from the rate pack, some differences in drained fruit weights after 3 months were caused by cover sirup type (Table 3). These differences were greatest in the 3 cherry packs and the peach halves where they were of statistical significance. The fruits packed in sirup No. 3 were found to have consistently low drained weights in these 4 fruit variations, while those in sirup Nos. 1, 2, and 5 maintained high drained weights of nearly equal magnitude in each of the 4 fruit variations. As was noted in the rate pack, differences between individual sirup effects were greatest in the Lambert cherry pack. There was no evidence from these results that sirup type had any effect on drained fruit weights in canned peach slices and pear halves after 3 months' storage.

Percentages of fill weights for the fruits after 3 months' storage were calculated and are given in parentheses in Table 3. Complete return to original fill weight was not observed in any instance. The greatest recovery was found for the peach and pear packs. This was in line with the more rapid increase in drained weights found for these fruits in the rate pack than was found for the 3 cherry packs.

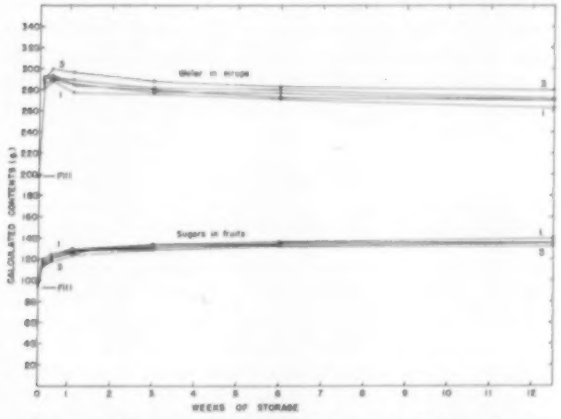

Figure 4. Changes in amounts of sugars in fruits and water in cover sirups with storage time. Average values for 6 canned fruit variations and 5 cover sirup types. Plots for sirup Nos. 1 and 3 identified.

Total amounts of sugars and water translocated in the individual fruit packs were calculated from sirup data, i.e., the arithmetical difference between fill amounts and amounts present at the 3 months' cutting. The averages for each fruit and sirup combination were tabulated as Table 4. The negative values obtained for the sugars indicated a loss from the sirup, i.e., sugars translocated from sirup to fruit. The algebraic sum of sugars and water translocations would represent the drained weight increase of sirup, or the drained weight decrease of fruit after 3 months' storage.

A statistical analysis of the translocation data indicated significant differences due to sirup treatment in the packs of peach halves, Bing and Lambert cherries. Notably, sirup No. 3 effected the least translocation of sugars and the greatest water translocation in these 3 packs during a 3 months' storage period. Sirup type effects on translocation in the packs of Royal Ann cherries, peach slices, and pear halves were neither significant nor consistent.

Calculation of sugars translocation from fruit data gave values in fairly close agreement with those calculated from sirup data. Values for water translocation calculated from fruit data were consistently higher than those calculated from sirup data, especially in the case of the Lambert cherry pack. This discrepancy could have been due to the fact that, in the case of the raw fruit, Brix is an inaccurate measure of soluble solids as sugars. Because of the relatively high water content of the raw fruits, the inaccuracy would be greatest in any calculation involving the product of fill weight of fruit and (100-Brix) of fruit at fill.

TABLE 4
Sugar and water translocation in canned fruits after 3 months' storage

Fruit pack	Calculated average translocation (g.)[1]					N[2]
	Sirup No.					
	1	2	3	4	5	
Royal Ann cherries	—18.0 (96.2)	—18.0 (98.7)	—18.2 (106.3)	—16.5 (96.0)	—18.8 (100.0)	6
Bing cherries	—6.9 (47.8)	—6.5 (50.1)	—2.7 (56.1)	—6.1 (50.7)	—5.3 (49.0)	8
Lambert cherries	—7.2 (68.7)	—7.5 (69.6)	—3.8 (81.6)	—4.4 (78.8)	—6.5 (76.3)	8
Peach halves	—74.3 (96.8)	—78.0 (95.1)	—73.0 (100.1)	—73.9 (99.5)	—75.3 (96.7)	8
Peach slices	—80.6 (112.5)	—79.8 (117.1)	—78.8 (117.2)	—78.6 (119.9)	—78.7 (120.2)	8
Pear halves	—48.7 (74.1)	—48.5 (74.7)	—49.6 (70.3)	—47.7 (75.5)	—48.3 (75.3)	6

[1] Negative values, movement of sugars from sirup to fruit; positive values in ( ), movement of water from fruit to sirup. Both calculated from sirup data.
[2] Number of batches (2 cans/sirup/batch).

DISCUSSION

Results of this investigation support an hypothesis based on a concept of rapid movement of water (and hydrogen ions) and relatively restricted movement of various sugars within a complex fruit matrix. The changes in drained sirup weights are similar to the changes in hydrostatic pressure proposed by Laidler and Shuler *(5)* for the case of a membrane more permeable to solvent than to solute. In the conditions set up by Laidler and Shuler the capillary is immersed in the more concentrated solution. Drained sirup weight changes, which are equal and opposite to drained fruit weight changes, are considered a measure of the hydrostatic pressure changes as used by these authors. However, only a small portion of the drained weight curves shows the predicted exponential relationships with time. Although the theoretical pressure-time relationships for permeable membranes may be operative in the case of the fruit matrix, the complex nature of the diffusion in this instance does not allow a calculation of permeation constants *(5)* from the data at hand. Simplified experiments, particularly with pure non-hydrolyzing sugars may yield data which fit exact mathematical description.

Hydrolysis of sucrose no doubt occurred, both in the sirups and in the fruits, under pH conditions of these experiments. Adams *(1)* reported a 2% inversion in canned cherry sirup immediately after canning, which increased to 27.9% after 6 months' storage. However, these values included invert sugars which diffused out of the fruit and into the sirup.

The best insight into the actual translocations which may occur during storage is seen from the changes in water and sugars (Figure 4). Initial shrinkage in drained fruit weights is clearly due to a large and rapid translocation of water from fruits to sirups, following the initial osmotic pressure gradient. A simultaneous movement of sugars from sirups to fruits favors rapid reduction of the osmotic pressure gradient until soon (about 3 days) there is an abrupt cessation of water transloca-

tion, likely due to an attainment of isosmotic conditions in fruit and sirup. However, since there is still a concentration gradient of individual solute species, sugars continue to diffuse into the fruits. In order that isosmotic conditions continue to obtain, water also must move from sirups to fruits, resulting in a reversal of direction of water translocations. This translocation of sugars and water from sirups to fruits may be expected to continue until each molecular species is of equal concentration (activity) in corresponding fruits and sirups. Apparently this true equilibrium condition is not reached at 3 months' storage and a further small increase in drained fruit weights may be expected after prolonged storage.

It will be noted that, although isosmotic conditions are postulated at the time of reversal of water movements, the Brix of fruits are still lower than the Brix of sirups. This can be explained on the basis of the relatively higher proportion of lower molecular weight molecules in the fruits at this time compared with the sirups.

Type and direction of *changes* of water and sugars in canned fruits are apparently very similar for the 5 sirup variations used in this study. Sirup type effects on translocations are evident, though, in some individual fruit packs after 3 months' storage. These may be seen from Table 4. Following indications evident in Figure 4, the least sugars translocations and the greatest water translocations occur in sirup No. 3 in 3 fruit packs, viz., peach halves, Bing, and Lambert cherries. The magnitude of the translocation is, thus, dependent on both sirup type and type of fruit pack. On the basis of the translocation hypothesis postulated, sirup type No. 3, containing a higher proportion of higher molecular weight sugars (including dextrins) would be expected to cause effects on drained weights, sugars and water translocations differing from the other cover sirups as indicated.

CONCLUSIONS

From the results and discussion presented in this paper, the following conclusions may be drawn for the 5 sirup variations and 6 fruit packs investigated:

Sirup cutouts (Brix) change very little after the first week following canning and, for any one fruit variation, are practically equal for all cover sirup variations.

Following an initial shrinkage during the first week's storage, drained fruit weights increase more or less gradually up to and beyond 3 months' storage.

The rate and extent of recovery of fruit drained weights are dependent on type of fruit pack and type of cover sirup.

The effects of sirup type and fruit pack on drained weights are caused by the relative translocations of sugars and water, which in turn are determined by intrinsic diffusion properties of individual sugar molecules in a particular fruit variation.

Further critical investigation of the translocation of sugars and water in canned fruits is indicated, using cover solutions of pure solute types, including selected sugar types with anticipated ranges of diffusion properties.

SUMMARY

The investigation was designed to show type and direction of changes during storage, and effects after 3 months' storage, for drained fruit weights and sirup cutouts (Brix) for 6 canned fruit variations and 5 cover sirup types. The data were used to determine the translocations of sugars and water which accounted for the observed effects. The magnitude and direction of the translocations were explained on the basis of diffusion properties of water and the individual sugar molecules in a complex fruit matrix.

It was concluded in this study that, for any one fruit, sirup cutouts were practically independent of cover sirup type, but that rate and extent of recovery of drained fruit weights were dependent on type of fruit pack and cover sirup type. One sirup variation relatively high in high molecular weight sugars showed the least sugar translocation into the fruit and the greatest water translocation into the sirup, resulting in the lowest drained fruit weight after 3 months' storage for 3 out of the 6 fruit packs.

Acknowledgments

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Evaluation of Thresholds and Minimum Difference Concentrations for Various Constituents of Wines. I. Water Solutions of Pure Substances

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This study reports an experiment to ascertain the detectable levels, for both threshold and minimum concentration differences, for a number of the major constituents found in grape wine. Pure substances were tested in water solutions. The object was to determine the flavor differences that could be detected, and to study the methodology involved. The effects of various factors, such as individual acuity, consistency of panel, and biases are reported. A standardized procedure for the determination of thresholds is described.

The major constituents in wine affecting organoleptic sensation are:

Ethyl Alcohol	*D*-Tartaric Acid
Dextrose	Potassium Bitartrate
Levulose	Citric Acid
Glycerol	*L*-Malic Acid
Ethyl Acetate	Lactic Acid
Acetaldehyde	Succinic Acid
Grape Seed Tannin	Sulfur Dioxide

These substances are present in wines either naturally or as additives.

The ethyl alcohol is formed from the fermentation of the grape sugars by the action of yeasts. The alcoholic content attained in wines by natural fermentation varies from 10 to 14% by volume, although values above and below this range are frequently found. Fortified wines of 18 to 21% alcohol are produced by the addition of grape brandy.

Both dextrose and levulose are found in the grape, the levulose to dextrose ratio increasing from 0.91 to 1.24 during maturation. As dextrose is fermented at a faster rate by the yeasts, the ratio found in wines varies with the degree of fermentation. Depending upon the type of wine produced, the reducing sugar content may vary from less than 0.2 g. per 100 ml. to about 16 g. per 100 ml.

According to Amerine *(3)*, newly finished wines contain per 100 ml., 0.15-0.49 g. tartaric acid, 0.046-0.338 g. lactic acid and 0.109-0.280 g. malic acid. Tartaric and malic acids occur in the grape, decreasing with maturity. Lactic acid is formed in small amounts from the fermentation, but may be increased at the expense of the malic acid if the wine undergoes a malo-lactic fermentation. Succinic acid is formed under aerobic conditions during fermentation in quantities of 0.05-0.20 g. per 100 ml., *(4)*. Citric acid, although naturally present in trace amounts in wine, is usually found in quantities of 0.05-0.20 g. per 100 ml. as an additive for the correction of natural deficiencies.

Potassium bitartrate occurs in the grape, and may have values of 0.10-0.50 g. per 100 ml. in the wine, depending upon the age and treatment of the wine. Sulfur dioxide, which is an added substance used as a preservative, is limited by law to 350 p.p.m. total sulfur dioxide. Tannin is found in the skins, stems and seeds of grapes, and in wine will range from 0.02-0.05 g. per 100 ml. for white wine, and from 0.10-0.30 g. per 100 ml. for red wine.

Glycerol, ethyl acetate and acetaldehyde are products of fermentation. Amerine and Dietrich *(6)* reported glycerol contents in California wines of 0.84-1.12 g. per 100 ml. Ethyl acetate is also formed by esterification during the aging of wine. A total content of 65-145 mgm. per liter as volatile neutral esters is given by Amerine and Joslyn *(5)*. Acetaldehyde in sound wines should be less than 100 mgms. per liter; higher concentrations result in a definite oxidized color and flavor.

METHOD

The triangular test procedure *(2, 7, 11, 12, 13, 15, 19)* was used throughout for the comparison of solutions. Two sets of 3 samples each were presented daily to each taster on the panel. The glasses were randomly coded, and all 6 possible arrangements of the triangular design were randomized and presented an approximately equal number of times in each test. The tasting was done in individual air-conditioned booths, equipped with a water fountain for oral rinsing. The samples were presented at room temperature, which varied from 24-26° C. The time of presentation was before lunch, 11:30 A.M. Each set of samples was tasted in the order given.

The panel consisted of 18-20 members, but an average of only 12-16 participated daily. The panel was purposely selected to provide two numerically equal groups: one composed of tasters who were very familiar with wine, and the other of those less acquainted with wine or essentially non-wine drinkers. This was done to permit comparison of the performance of the 2 groups. All members were trained in the perception of the various constituents; *i.e.*, they were familiarized with the particular substance by description of the taste or odor as part of the instructions in the questionnaire, and in many cases a test sample of sufficient concentration to be recognized by all was given at the first tasting.

The judges were required to check the duplicate samples on the score sheets and also to indicate whether the duplicates or the odd sample, as selected, had the higher concentration of the substance under study. The tasters were requested to make a separation and quality designation even if they had to guess. However, the statistical significance for these experiments was based upon judgments for separation only.

Those substances having a tendency to fatigue or deaden the senses, such as tannin or sulfur dioxide, were given in only one of the two daily sets, usually the second, while the other set contained a milder substance.

About one ounce of liquid was served in each glass to allow the taster an opportunity to refer back two or three times within the set before making judgment. Differences in color, when such existed, were eliminated by the use of black-painted beakers and of colored filters on the lights in the tasting room. Otherwise, large, stemmed goblets of clear glass were used.

In order to establish significance, a probability level of $p = 0.001$ was adopted, to be derived from 26-50 judgments at the

particular concentration level. This procedure, it was believed, would minimize the fluctuations due to the tasters having off-days, and the very highly significant probability level would give more reproducible results. The method was modified later to improve consistency of the results.

In determination of thresholds, the concentration of the substance being tested was varied until a confidence level of just 5% was attained at a single sitting of the panel. This concentration was then given to a second sitting of the panel. If the pooled results of the 2 sittings gave a significance of $p = 0.001$, a lower concentration was presented to the panel. The concentration adopted as threshold was the lowest level at which a significance of $p = 0.05$ or better was obtained in two or more of the individual sittings, provided that the pooled results gave a significance of $p = 0.001$. The same concentration was never presented more than 3 times.

The substances used were of the highest purity available. The lactic acid was of C. P. purity, the glycerol 96%, U.S.P., the ethyl alcohol was a triple-distilled neutral grape spirits of 95.5% alcohol by volume, and the tannin was an Australian grape seed tannin of 67.5% tannic acid content determined by the Loewenthal *(1)* procedure. The acetaldehyde used was purified by fractional distillation and diluted with water to a stock solution of 5 g. per 100 ml. to prevent polymerization. The malic acid used was recrystallized from a water-alcohol solution to remove a foreign odor which would have affected the tasting results. Sulfurous acid was prepared by bubbling sulfur dioxide gas into water; its concentration was determined by the Ripper *(1)* method. The water used was freshly distilled from a nickeled Barnstead still, and aerated before use. Its pH was 5.8-6.0.

EXPERIMENTAL RESULTS AND DISCUSSION

Two methods were compared for the establishment of threshold and minimum difference concentrations. One was to assume a definite level of confidence of $p = 0.001$, and then conduct tests at varying concentrations until the required number of correct judgments was obtained. The other method, mentioned by Lockhart and Stanford *(14)*, required the assumption that the percent of correct judgments was a measure of the intensity of sensation, or a measure of the difference in intensity of sensation between 2 samples, as the case may be. In other words, in binomial designs, if P_e is the percent of correct judgments obtainable by chance, P_o is the percent of correct judgments observed in the test, and P_c is the percent of correct judgments over and above chance, the following relationship will hold:

$$P_c = k(P_o - P_e) \quad . \quad . \quad . \quad . \quad (1)$$

where k is a constant depending upon the type of binomial design being used.

For the triangular test, $P_e = 33.3\%$, since one-third of the judgments may be correct by chance. Two conditions are made: when P_c is zero $P_o = P_e$, and when $P_c = 100\%$ $P_o = 100\%$.

Substitution into equation (1) gives the following for the triangular design:

$$P_c = 3/2\ (P_o - 33.3) \quad . \quad . \quad . \quad (2)$$

According to Guilford *(9)*, a threshold may be taken to be the concentration or difference in concentration of flavor or odor which could just be detected 50% of the time. Therefore, the concentration for which $P_c = 50\%$ could be adopted as a threshold.

Table 1 shows the thresholds obtained for various substances in water by the 2 methods. The 2 procedures gave good agreement.

From the table, the sweetest substance (lowest threshold) was levulose, followed by sucrose, glycerol and dextrose in that order. This is in agreement with the work of other investigators [Cameron *(8)*].

For those compounds demonstrating acidic or sour properties, sulfurous acid appeared to have the lowest threshold level. However, this may have been due to the fact that this substance stimulates odor and chemical receptors as well as taste.

TABLE 1

Threshold concentrations of various constituents of wine

Substance	Threshold concentration			
	$p = 0.001$			$P_e = 50\%$
	pH	Corresponding normality	gm./100 ml.	gm./100 ml.
Levulose			.15	.13
Sucrose			.30	.31
Glycerol			.38	.44
Dextrose			.40	.44
Sulfurous Acid	4.05	.00027	.0011	.0011
Sulfuric Acid	3.55	.00031	.0015	.0013
Tartaric Acid	3.75	.00033	.0025	.0027
Citric Acid	3.95	.00039	.0025	.0023
Pot. Bitartrate	4.15	.00040	.0075	.0090
Lactic Acid	3.80	.00044	.0040	.0038
Malic Acid	3.85	.00045	.0030	.0026
Succinic Acid	4.00	.00059	.0035	.0034
Ethyl Alcohol			.0040	.0052
Ethyl Acetate			.0008	.0011
Acetaldehyde			.00015	.00013
Grape Seed Tannin			.020	.020

Although the pH values of the threshold concentrations fall in a narrow range, they vary somewhat from acid to acid. This suggests the possibility that the taste properties are not strictly due to the hydrogen ion, but may be influenced slightly by the nature of the anion and the undissociated acid [Cameron *(8)*]. The difference in threshold concentrations of weaker acids may be explained by Ventre's *(18)* statement that tartaric acid possessed a hard, acid taste whereas malic acid had a 'soft,' fruity taste.

At low concentrations ethyl acetate and acetaldehyde gave odor sensations only. The threshold for tannin was difficult to establish as the astringency of the test solutions caused a rapid, persistent deadening of the taste buds resulting in lowered perception of subsequent samples in the triangle.

The detectable concentration differences for various substances in water solutions are given in Table 2. The concentrations in column 2 are those of the lower samples in each pair of samples compared, while columns 3 and 4 indicate the concentration increment required to obtain a difference detectable organoleptically.

The bias reported by Harrison and Elder *(11)*, for the middle sample being chosen as odd, was observed in these experiments also. An analysis of the judgments by the panel over a period of 6 months is given in Table 3. Of the total 2154 sets of triangles, in which the arrangement was randomly assigned, 713, or nearly the predicted one-third, actually had the odd sample in the middle. However, the middle sample was judged to be odd 781 times, demonstrating a highly significant bias.

TABLE 2
Detectable concentration differences for various substances in water solution

Substance	Concentration gm./100 ml.	Difference for $p = 0.001$ gm./100 ml.	Difference for $P_e = 50\%$ gm./100 ml.
Dextrose	1.0	0.4	0.7
	5.0	0.6	0.8
	10.0	0.8	0.8
	15.0	1.0	1.1
Ethyl Alcohol	4.0	1.2	1.5
	8.0	1.6	2.4
	12.0	2.4	3.2
	16.0	2.8	...
D-Tartaric Acid	0.25	0.05	
Pot. Bitartrate	0.30	0.10	
Citric Acid	0.21	0.07	
L-Malic Acid	0.23	0.05	
Sulfur Dioxide	0.002	0.002	
Ethyl Acetate	0.003	0.004	

In the triangular test as used, the tasters frequently remarked that they were able to distinguish easily between 2 of the 3 samples, but at near threshold values it became difficult to match the third sample with either one or the other of the first two. In such a situation, the sample designated by the taster as odd would necessarily have to be correct in quality or intensity identification [Guymon *(10)*]. This condition exists to a significant degree *(8)*, and is further exemplified in Table 3. When

TABLE 3
Distribution of judgments

Total Judgments	2154
Middle Sample As Odd	
By Random Distribution	713
Observed Choices	781[1]
Total Incorrect Separations	817
With Correct Quality Designation of Odd	540
With Incorrect Quality Designation of Odd	277

[1] — $p = 0.01$.

separations were incorrectly made, the sample designated as odd by the taster was correctly identified as to quality or intensity in 540 cases out of 817. If chance had been the only element involved, the numbers of judgments in each quality or intensity category should have been more nearly equal.

Table 4 is the result of separation of the judgments into 2 groups; one, those at or above threshold level for the panel, and the other, those below threshold. It is evident that even when incorrect separations are made, the quality identifications of the individual samples are not randomly chosen. The proportion of correct to incorrect identifications of the odd sample in cases of incorrect separation is about the same above and below

TABLE 4
Odd sample designation

	Above threshold	Below threshold
Total	1696	458
Correct Separations	1142	195
Correct With Correct Identification	1082	165
Correct With Incorrect Identification	60	30
Incorrect Separations	554	263
Correct With Correct Identification	372	168
Correct With Incorrect Identification	182	95

threshold. This would suggest that the taster is able to separate and identify two of the samples in the majority of the cases, but that carry-over of taste or some other factor causes confusion in the judgment of the third sample.

When only a small proportion of daily panel tests at any one concentration individually give significant results, yet the pooled result from a large number of replications is significant, it leaves doubt whether or not the level should be adopted as threshold for the panel. In Table 5 are shown the results of daily tabulation of

TABLE 5
Single tests vs. pooled results for threshold determinations by triangular method

Sucrose 0.2% in water			Sucrose 0.3% in water		
Total	Correct	Incorrect	Total	Correct	Incorrect
9	4	5	10	6	4
8	6	2[3]	10	9	1[3]
7	3	4	7	5	2[3]
7	1	6	7	6	1[3]
12	8	4[3]	15	9	6[1]
6	3	3	15	8	7
11	6	5	17	11	6[2]
15	8	7	18	10	8[1]
13	9	4[2]	17	4	13
19	8	11	19	11	8[1]
16	6	10	17	9	8
17	8	9			
19	11	8[1]			
13	4	9			
172	85	87[3]	152	88	64[3]

[1] $p = 0.05$.
[2] $p = 0.01$.
[3] $p = 0.001$.

judgments for sucrose 0.2% and 0.3% compared against water. In the case of sucrose 0.2% against water, there were only 4 significant tests out of 14, although a very highly significant threshold was established for this level from the pooled result. This would appear to be a false threshold, or at least an inconsistent one. It would seem more logical to accept the 0.3% level as the threshold,

TABLE 6
Comparison of percent correct judgments—experienced group vs. inexperienced group

Concentration gms. per 100 ml.	Group I experienced testers	Group II inexperienced testers
Alcohol (Ethyl)		
0	66	60
5	57	52
10	50	56
15	50	56
20	49	66
Acidity (Citric, Malic, Tartaric Acids)		
0	50	63
0.25	58	46
Sweetness (Dextrose)		
0	46	59
1	47	55
5	59	58
10	50	67
15	62	49
Astringency (Tannin)		
0	59	48
Body (Glycerol)		
0	73	60
Odor		
Acetaldehyde	81	69
Ethyl Acetate	72	59
Sulfur Dioxide	64	65

which, with 7 significant tests of a total of eleven, definitely was reproducible.

Since the panel comprised 2 groups, one consisting of expert wine tasters and the other with little or no experience with wine, it was of interest to determine the difference in response between the 2 groups. In Table 6 the results are given for various substances tested at a number of concentration levels. The 2 groups are compared in terms of percent correct judgments at any given level, Group I being the experienced members and Group II, the non-experienced members. For the sensations given by alcohol, acids, or sugars, neither panel shows any particular superiority. For detection of astringency (tannin), body (glycerol), and certain odors (acetaldehyde and ethyl acetate), the data, though meager, appear to indicate that the experienced group is superior.

Differences in acuity between tasters have been noted [Salmon and Blakeslef *(17)*]. In these experiments ethyl acetate, in particular, demonstrated the wide variation in threshold sensitivity for different tasters. There were some who were unable to detect ethyl acetate below 30 p.p.m., while others were able to consistently detect it at a level of 6 p.p.m. Glycerine was another substance eliciting large differences in individual response. Some members of the panel were unable to detect glycerine below 0.55 g./100 ml. while others were able to detect 0.35 g. per 100 ml.

SUMMARY

Threshold concentrations for levulose, sucrose, glycerol, dextrose, sulfurous acid, sulfuric acid *D*-tartaric acid, citric acid, lactic acid, *L*-malic acid, succinic acid, potassium bitartrate, ethyl alcohol, ethyl acetate, acetaldehyde and grape seed tannin in aqueous solutions were determined. Minimum detectable concentration differences for dextrose, ethyl alcohol, *D*-tartaric acid, citric acid, *L*-malic acid, potassium bitartrate, sulfur dioxide and ethyl acetate were also determined.

A bias for choosing the middle sample as odd was noted. Also, in those cases in which incorrect pairing occurred, the number of correct identifications of the odd sample was significantly greater than the incorrect identification.

Differences in ability between experienced wine tasters and inexperienced were not significant.

Acknowledgment

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Color Differences of Citrus Juices and Concentrates Using the Hunter Color Difference Meter[a,b]

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The Hunter Color Difference Meter has been used to measure color differences in orange, grapefruit and other citrus juices and concentrates. Color differences caused by such factors as fruit variety, pulp content, blending of juices, and storage were measured with this instrument.

Color, an important characteristic of citrus juices and concentrates, is affected by fruit variety and maturity, processing methods, and other factors. Accurate and practical methods for measurement of the color of juices and concentrates are desirable so that processors may pack throughout a season products of uniform color and so that regulatory agencies may establish future standards on data accurately obtained and carefully evaluated.

The complex subject of color and its measurement has been adequately covered by Judd *(7)*. In the past, color of food products has been measured chiefly by subjective methods, such as the use of the Maxwell spinning disk *(11)*, the *Munsell Book of Color (10)* and the Maerz and Paul *Dictionary of Color (9)*. During recent years much has been done to develop instruments to measure objectively color or color differences in products. For obvious reasons such methods are preferred over subjective procedures. Eastmond *(3)* and recently Slater *(14)* have discussed the various types of instruments now available for the measurement of color. Younkin *(15, 16)*, Buck and Sparks *(1)*, Desrosier *(2)*, and Kramer *(8)* reported on the use of various instruments for color measurement of tomato products. Robinson *et al. (12)* compared the use of the Beckman quartz spectrophotometer, the Hunter Color Difference Meter, the Photovolt Reflection meter, and the Maxwell spinning disk for the measurement of color reflectance in canned tomato juice. A study of methods and instruments for specifying the color of frozen strawberries was made by Shah and Worthington *(13)*, using the same instruments previously mentioned.[c]

Since the Hunter Color Difference Meter had been used successfully to measure color differences in tomato juices, strawberries, and other fruit and vegetable products, this investigation was undertaken to determine if this instrument would be satisfactory for measuring the color of citrus juices and concentrates and color differences in these products caused by such factors as fruit variety, pulp content, and storage.

[a] Cooperative research by the Florida Citrus Commission and Florida Citrus Experiment Station. Florida Agricultural Experiment Station Journal Series, No. 283.

[b] Presented at the Fourteenth Annual Meeting of the IFT, Los Angeles, Calif., June 29, 1954.

EXPERIMENTAL PROCEDURE

The Hunter Color Difference Meter is a photoelectric tristimulus instrument, the design and operation of which have been described by Hunter *(5)* and Judd *(7)*. The instrument was standardized using a NBS enamel plaque, test number G13383, with values of $R_d = 60.7$; $a = -2.0$; $b = 22.7$. A No. 8010-100 Hellige glass turbidimeter tube with fused-on bottom plate was used as a sample holder. This tube was approximately 56 mm. inside diameter and 142 mm. in height. Approximately 250 ml. of thoroughly mixed product was placed in this sample holder and readings were made immediately, so that separation and settling of insoluble solids could be kept to a minimum. A large area of illumination, a large aperture and the R_d scale were used.

A Beckman DU spectrophotometer was used with reflectance attachment to determine differences in the spectral reflectance curves for concentrates made from different varieties of citrus fruits. A reflectance curve for a sample of reconstituted commercial frozen orange concentrate was obtained by means of a G. E. recording spectrophotometer.[c]

[c] Courtesy of Dr. B. A. Brice, U. S. D. A., Eastern Utilization Research Branch, Philadelphia.

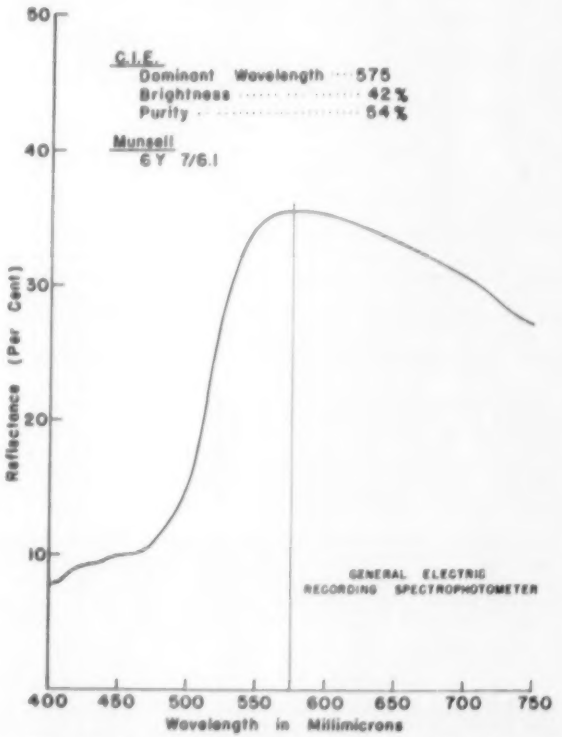

Figure 1. Spectral reflectance curve for reconstituted frozen concentrated orange juice.

EXPERIMENTAL RESULTS AND DISCUSSION

A spectral reflectance curve for a sample of reconstituted frozen orange concentrate is shown in Figure 1. Using this reflectance curve the authors calculated the C. I. E. values for Illuminant C by the selected ordinate method *(4, 6)* and obtained a dominant wave length of 575 mμ, a brightness of 42% and a purity of 54%. These C. I. E. values corresponded to Munsell notation 6Y 7/6.1. The visual color of such a Munsell chip would be different from the visual color of orange juice. Similarly, the conversion of Hunter Color Difference Meter readings for R_d, a, and b for orange juice to Munsell notation showed that the reflected color, as indicated by the instrument, did not match that visually observed. Thus it became evident that neither the G. E. recording spectrophotometer nor the Hunter Color Difference Meter was satisfactory for determining the color of orange juice as actually seen by an observer. Citrus juices are neither completely transparent nor opaque, and the translucent nature of these products makes the measurement of their color impossible using instruments now available.

Spectral reflectance curves, similar to that shown in Figure 1, were obtained for concentrates made from different varieties of citrus fruits grown and used in Florida by using a Beckman DU spectrophotometer with a reflectance attachment. The differences in the color, which was visually evident, of products made from Hamlin, Pineapple, and Valencia oranges and Dancy tangerines were indicated by the shape of the various spectral curves. The peaks of these curves occurred at approximately the same wavelength but the percentage reflectance was greatest for the tangerine and smallest for the Hamlin concentrate.

Results reported in Tables 1-6 are color difference measurements for different citrus products, using the Hunter Color Difference Meter standardized against a NBS enamel plaque with values of $R_d = 60.7$, $a = -2.0$, and $b = 22.7$. Samples listed in Table 1 were frozen orange concentrates obtained from 3 commercial plants during the 1952-53 season. Measurements were made on both the concentrates and the reconstituted juices. Considering the samples from Plant A, it is evident that significant differences and trends were found in both the R_d and a values. The most important trend was the increase in redness in the concentrates as the season progressed, this being indicated by a gradual increase in the value of a. The amount of the yellow component in the color did not vary greatly as is shown by the small changes in the b value. In the samples from Plants B and C the more significant differences in color were in the red component. In all of these samples during the first part of the season, when early varieties of fruit were being processed, the visual color of the reconstituted concentrates was yellow-green, which changed as the season progressed to a yellow-orange or orange. These same trends in color, as indicated by data in Table 2, were found in samples of single-strength canned orange juices collected monthly during the 1953-54 season from some commercial canning plants.

Color differences between fresh citrus juices extracted from different varieties of fruit are demonstrated by data in Table 3.

TABLE 1

Color measurements by the Hunter Color Difference Meter of frozen orange concentrates obtained from Florida plants during the 1952-53 season

Date packed	Concentrates			Reconstituted juices		
	R_d	a	b	R_d	a	b
Plant A						
1-28-53	21.3	3.1	29.6	18.3	—6.7	25.8
2- 6-53	20.1	3.1	30.1	19.1	—6.6	26.6
3-13-53	18.4	4.2	30.2	17.8	—5.9	27.4
3-24-53	18.9	5.1	30.3	17.0	—5.4	26.8
4- 3-53	17.6	6.3	29.3	17.2	—4.2	27.1
4-29-53	15.9	6.7	28.7	16.6	—3.9	27.2
5- 8-53	15.8	5.8	28.5	16.7	—4.4	26.4
Plant B						
1-27-53	18.8	3.2	29.7	18.8	—5.8	26.4
2-11-53	19.7	3.0	30.3	20.3	—6.5	26.9
3-12-53	17.5	4.2	29.5	19.6	—5.7	28.1
3-21-53	17.2	6.7	29.4	18.1	—3.7	27.6
4-30-53	19.0	5.6	30.2	19.0	—5.1	27.1
7-13-53	18.6	6.9	30.2	18.3	—3.6	27.2
Plant C						
1-26-53	21.0	2.2	31.2	20.6	—7.2	27.3
2-12-53	20.7	2.7	30.6	19.8	—7.1	26.7
3- 7-53	21.3	4.0	31.5	21.0	—5.8	27.9
3-13-53	19.8	5.9	31.2	20.3	—4.2	28.9
3-28-53	19.1	5.9	30.8	19.5	—4.3	28.6
4-29-53	19.5	7.4	31.2	20.1	—2.9	29.0

TABLE 2

Color measurements by the Hunter Color Difference Meter of canned orange juices obtained from Florida plants

Month obtained	R_d	a	b
October, 1953	22.6	—7.9	25.2
November, 1953	22.7	—7.1	26.3
December, 1953	24.2	—6.2	27.4
January, 1954	21.5	—5.0	27.7
February, 1954	21.7	—4.5	29.3
March, 1954	24.5	—3.6	30.0
April, 1954	22.2	—2.4	29.2
May, 1954	20.5	—1.9	28.4

TABLE 3

Color measurements by the Hunter Color Difference Meter of juices from different varieties of citrus fruits

Variety	R_d	a	b	Visual color
Hamlin orange	14.3	—8.0	19.2	Yellow—green
Pineapple orange	15.7	—6.5	24.3	Light orange
Valencia orange	15.0	—5.3	26.1	Orange
Temple orange	12.5	—5.4	22.4	Orange
Duncan grapefruit	12.6	—7.4	6.2	Light green—yellow
Marsh grapefruit	10.3	—7.0	6.4	Light green—yellow
Ruby Red grapefruit	10.8	—1.8	8.6	Pink
Dancy tangerine	17.1	—1.8	26.8	Dark orange

Juice from the Hamlin orange, an early variety, contained the smallest amount of redness, and was predominantly yellow-green. Juice from Dancy tangerine, which had a dark orange color, had a value for a of —1.8 indicating the largest amount of redness in any of the juices examined. The grapefruit juices contained less yellow component than the orange juices as signified by the lower b values. The principal difference between the color of Hamlin orange juice and the grapefruit juices was in the quantity of the yellow component.

Data in Table 4 show that the amount of pulp, which consists chiefly of particles of juice sacs, rag and albedo, does affect the color of concentrated citrus juices.

Color differences in blends of several reconstituted citrus concentrates are shown in Table 5. The blending of Valencia orange concentrate with concentrated juices made from early varieties of oranges, such as the Hamlin, results in a product having a more intense orange color than that of a concentrate made entirely from Hamlin oranges. Measurements with the Hunter Color Difference Meter definitely show the increase in

TABLE 4

Color measurements by the Hunter Color Difference Meter of experimental citrus concentrates containing different amounts of pulp

Variety	Reconstituted juices	Concentrates		
	Pulp—% volume	R_d	a	b
Pineapple orange	5	11.8	0.1	24.4
Pineapple orange	6	12.2	0.8	24.9
Pineapple orange	8	12.8	1.2	25.2
Pineapple orange	8	13.1	1.3	25.5
Duncan grapefruit	3	12.4	—6.7	13.3
Duncan grapefruit	5	13.3	—6.6	14.0
Duncan grapefruit	6	14.2	—6.6	14.5
Duncan grapefruit	9	15.5	—5.9	15.5
Dancy tangerine	3	14.1	7.2	26.6
Dancy tangerine	3	14.6	8.1	27.0
Dancy tangerine	4	14.7	8.7	27.2
Dancy tangerine	5	15.2	9.3	27.5

TABLE 5

Color measurements by the Hunter Color Difference Meter of blends of reconstituted citrus concentrates

Blend	Hamlin*–Valencia			Duncan*–Hamlin			Duncan*–Valencia		
% volume	Rd	a	b	Rd	a	b	Rd	a	b
100*	13.5	—7.8	21.8	11.6	—7.5	4.1	11.6	—7.5	4.1
90	13.4	—7.4	22.1	11.3	—8.1	8.9	11.4	—7.8	12.6
80	13.5	—6.9	22.6	11.7	—8.3	12.2	11.5	—7.4	16.4
70	13.4	—6.3	22.9	11.6	—8.3	14.4	11.6	—6.8	18.2
60	13.4	—6.0	23.3	11.3	—8.5	16.2	12.1	—6.3	20.2
50	13.3	—5.1	22.6	11.4	—7.9	17.0	12.4	—5.8	21.6
40	13.3	—4.6	22.9	11.9	—8.1	18.6	13.0	—5.1	22.5
30	13.3	—4.3	23.7	11.7	—7.7	19.1	13.0	—4.5	23.3
20	13.5	—3.9	24.0	11.7	—7.4	19.3	13.2	—3.9	24.1
10	13.2	—3.2	23.7	12.6	—7.3	20.9	13.5	—3.5	24.3
0	13.8	—2.6	24.5	11.7	—7.2	20.8	14.4	—3.1	24.6

TABLE 6

Color measurements by the Hunter Color Difference Meter of processed citrus products after storage at different temperatures

Storage, 12 mo.	Pineapple Orange Juice			Valencia Orange Juice			Grapefruit Sections [1]		
° F.	Rd	a	b	Rd	a	b	Rd	a	b
32	23.1	—4.9	28.4	21.2	—3.8	27.5	24.5	—7.4	15.3
60	23.5	—5.1	28.5	21.4	—3.6	28.1	25.0	—7.2	15.8
70	23.5	—4.9	28.3	21.3	—3.6	28.3	25.1	—6.3	17.0
80	22.9	—4.8	29.0	21.2	—3.6	28.3	22.9	—4.8	17.0
90	—	—	—	19.5	—2.7	27.5	17.3	—1.2	18.2

[1] Slurry prepared from drained sections using a Waring Blendor.

the yellow and red color components that result when blends of orange and grapefruit juices are made. When Hamlin orange juice is blended with Duncan grapefruit juice, the resulting blend shows only an increase in yellowness, whereas when Valencia orange juice is mixed with the grapefruit juice an increase results in both redness and yellowness.

Data in Table 6 definitely indicate no significant change in the color of canned single-strength Pineapple or Valencia orange juices during storage of these products for one year at various temperatures. Slight color changes in canned grapefruit sections occurred after storage at 70° F. for one year, and a marked darkening of this product was indicated in samples stored for one year at 80° F. and 90° F.

SUMMARY

Color differences in fresh and processed citrus juices and concentrates occur because of such factors as fruit variety, pulp content, and storage. Although these color differences can be objectively measured with the Hunter Color Difference Meter, neither this nor any other instrument now available is satisfactory for determining objectively the actual visual color of a citrus juice as seen by an observer.

The Hunter Color Difference Meter can be used to investigate changes that take place in processed citrus products during processing and storage. It is also useful for measuring color variations in commercial products to provide data which may be used as the basis for establishing future quality standards.

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The Relationship Between Food and Packaging Technology

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The food industry is most aggressive and demanding in its packaging requirements. It challenges the experienced packaging executive and technologist with ever-changing standards and the necessity of maintaining the shelf life of newly developed processed foods. In considering a problem in food research in its entirety, it is impossible to divorce it from packaging. The progressive food processor cannot advisedly maintain food technologists on his payroll without packaging technologists.

Few other phases of American business have received more attention, in the last three or four years, than the packaging of merchandise. Evedince for this lies in the increasing number of technical meetings held on the subject each year. Last year no less than six separate major technical associations or societies devoted much time to packaging meetings. It is further noteworthy that the attendance was made up of serious-minded executives and top level technical personnel whose interest has grown steadily with the advancement of packaging technology. The general subject matter discussed at these meetings is factual, substantiated with experience rather than sales propaganda, pure speculation, or optimistic theorizing.

Packaging is in excess of a ten billion dollar business annually. It is a growing industry. Its problems are often technical and since its opportunities as a career are limitless, individuals and industry are demanding educational programs. Some colleges, universities, and other educational institutions are recognizing the importance of packaging technology as a phase of industrial life and are prepared or plan to give training in this field on the same level that engineers, chemists, food technologists, and business administrators are educated. Short courses, conferences, and full credit courses are now available.

EXACTING DEMANDS OF THE FOOD INDUSTRY

The food industry is the most aggressive and the most demanding in packaging requirements. It challenges the experienced packaging executive and technologist with ever-changing standards and the necessity of maintaining the shelf life of newly developed processed foods. The food industry wants more convenience in its packages, greater eye-appeal, more suitable sanitary materials, faster filling, sealing labelling, cartoning and casing—all at a cheaper price. The food industry wants its packages geared to meet the ever-changing methods of distribution and to fit into modern chain store operations as well as the Mom and Pop store. Packages must stack well on shelves and be adaptable to a display in the center of an aisle. They must be constructed to withstand the ravages of an attack when they are stacked chin-high on a fast turn of a super market speedway.

The packaging technologist is faced today with many strange and new requirements in producing a sucessful package. Since the housewife may want to freeze or refrigerate the food she buys, store it at room temperature and then bake or serve it from the package, and the manufacturer may want to be able to display the product on television, the packaging technologist must consider many points in designing the package. From the marketing angle, moreover, it may be expedient to produce an item of reuse value, a cocktail glass, for instance. The influence children have in selecting certain products cannot be overlooked. Some such ideas as a storage chest for toys or a toy itself may be used to good advantage in the design of a container.

Technical problems. The difficult technical problems of packaging are just as numerous as design problems. Interior coatings on tin cans are not satisfactory if they stain to even the slightest degree. Glass container research constantly has the problem of reducing breakage, improving closures, and shipping carton materials.

In considering a problem in food research in its entirety, it is impossible to divorce it from packaging. Whether advances in food technology or advances in packaging technology are primarily responsible for the present day super market with its rows of food products of all kinds on display is a question that can be discussed at great length. It certainly cannot be denied that bringing the cracker and cookie from the barrel to a carton with inner wrap and stay-fresh packaging ideas contributed greatly to that industry's growth.

It is evident that the production of tin cans and vacuum glass containers is a direct measure of the growth and the progress of the process food industry. It is equally evident that the economy of paper and high volume production speeds in the manufacture of cartons is basic to the successful, volume merchandising of today's cereals, frozen foods, and ice cream. This generalization—that packaging progress is industry progress—can be applied to nearly every food item produced. Watermelons, bananas, and cantaloupes are among the hold-outs, although bulk packaging methods are even improving the chances of survival for these items. Packaging of bananas on the stalk in polyethylene bags is decreasing spoilage and bruising during shipping, and increasing sales.

The important part packaging considerations play in the development of a new or improved processed food product has been demonstrated many times and in many ways. Evidence of this was seen recently at Kraft Foods Company where in the circulated minutes of the final meeting on a new product, 40% of the total transcript was occupied by packaging considerations.

Packaging technologists complement the food technologists. A progressive food processor cannot advisedly maintain food technologists on his payroll without packaging technologists. The packaging phase of food production is too broad to expect the food technolgist to be a package technician also. It is becoming more and more evident that an organization needs to have a separate group to handle packaging problems. These problems are diverse—involve not only the package but also the packaging materials—metals, glass, plastics, paperboard, and corrugated fiberboard; they involve labels, glues, inks, waxed or coated papers, foil, parchment, tapes and string. Packaging problems may also include those that relate to filling and closing equipment, bagging machines, bundling or overwrapping devices, shipping case loaders, palletization and materials handling. A packaged food product does not ride the deluxe extra-fare route to the consumer. It bounces along a conveyor and bangs to a stop, it is thrown on a pallet, next put in a railroad car (the springless type) or in a truck. Then the product goes into a very hot or very cold warehouse, on to another truck to a store and finally to the display shelf. Here it must stand—neat, clean, attractive, and appealing—begging each passerby to purchase it. These are packaging problems—just as vital to the food industry as the other problems we encounter.

Aseptic processes must have packages that protect the product on its way to the consumer. Flavor and quality are maintained by proper packaging. A recent survey proves that the greater percentage of food buying is of the impulse type and anyone who ignores the package as a front-line super salesman, capable of moving a product from the store shelf to the consumer's market basket, is still in the dark ages of food merchandising.

The packaging materials industries have for many years realized the tie between food and package technology and have maintained a staff of food technologists to assist in developing better packages. Kraft Foods Company has recognized the relationship of food and packaging technology and placed its packaging group in the research department where combined skills can more quickly and scientifically produce a packaged product that satisfies the production, sales, and advertising management. Kraft research literally delivers to its management the goods in a nice, neat package ready for the market.

The package is now known to be a vital part of the product and as such must receive more than perfunctory attention from management. It is conceivable that the package may determine the process used on the food or the reverse. The packaging equipment may also limit the materials that can be used. Sometimes consumer convenience rules out a material which would have been very desirable from the protective angle.

QUALIFICATIONS OF THE PACKAGING TECHNOLOGIST

The packaging technologist then is a composite of many things, if he is a single individual at all. He has ready access to management thinking on new products, old products, and future products. He appreciates production problems on equipment, available space, labor costs, inventories, shipping and quality. He knows the ramifications of technical research and development and the methods thereof, he has the means of testing and approving materials, and he knows the engineering methods available, such as package filling, sealing, conveying, and wrapping. The packaging technologist understands sales requirements, objectives or goals, and appreciates the market reactions to packages from the wholesaler, retailer, and consumer viewpoints. He cooperates with the advertising department to see that the package has high merchandising value and consumer appeal built into it. He is sympathetic with the purchasing department and does not place them at a disadvantage by selecting hard-to-get materials with limited sources of supply. He further recognizes the food technologist's problems and is prepared to cope with the requirements outlined by him as basic from a protection standpoint. And finally, he enjoys the friendship and confidence of the many supplementary organizations that can help him—the material suppliers, convertors, machinery manufacturers, and the process engineers.

New Developments in Paperboard Containers

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In reporting on new developments in paperboard containers, consideration should first be given to some basic features of paperboard packaging. Fundamentally the purpose of making improvements in paperboard containers is to extend these basic properties to new applications. These basic properties are rigidity, durability and ease in handling, light weight, effectiveness for advertising display, and low cost. By the incorporation of various barriers with paperboard, especially in the case of food packaging, improvements in the protective and preservative properties of the container can be obtained which greatly extend their usefulness. The degree of improvement necessary and desirable is of course regulated by the cost of competitive packaging, and the shelf life protection justified by the product itself. The barriers which are to be considered here are concerned with the prevention of the passage of water, water vapor, oils, grease, odors, flavors, oxygen, and insect pests.

BARRIERS

Barriers can be generally classified in two groups, *supported* and *unsupported*. Unsupported barriers include foil, plastic films, waxed paper, greaseproof, and glassine. Supported barriers, which might be more familiarly designated as coatings, include petroleum waxes as well as plastic films and coatings.

As a barrier for water and water vapor, petroleum waxes have in the past been used almost exclusively. This is primarily because they are cheap, and also because they provide an excellent barrier when well supported. On scored and folded edges of paperboard, however, petroleum waxes will crack and at these points their barrier effectiveness is considerably diminished. There are methods of getting around this in many cases, however, and in other cases, where a completely tight barrier is not necessary, plain wax coatings are highly desirable.

At the present time plastic films and coatings are severalfold more costly than paraffin wax on an area basis and in order to be economically justified on the basis of protection alone, the package must be much more effective. It is not unreasonable therefore to expect such a differential in performance and it is found that in most cases this relation between cost and protection can be met.

APPLICATIONS

As illustrations of the applications of these barriers and of other new developments in paperboard containers, some fields of the food industry where these developments have played an important part will be considered here. These will be dairy products, frozen foods, meat products, and dry foods. Pressure for new packaging developments in all of these lines is resulting from increased emphasis on factory packaging of retail merchandise for self service marketing. The development of a self service package was first perfected a number of years ago for the more durable lines of food such as salt, sugar, flour, cereals, etc. Now that self service merchandising has become firmly established, most new items which are to be introduced must be correspondingly packaged. Accordingly many of the interesting new developments in paperboard containers for foods are proceeding along these lines.

Dairy products. The use of the paperboard milk carton is not a new development by any means except that it is worthy of note that practically all milk now being sold over the retail counter is in paperboard and the use of paperboard for home delivery is continually increasing. At the present time about half of the entire U. S. production of milk consumed in homes is packaged in paperboard, and as we found out during the Korean conflict, resin adhesives for milk cartons can get as high a priority on vinyl plastics as any military requirements.

The conventional wax dipped milk carton was first to be introduced, but a plastic coated carton has also been available in this country for the last few years and other more radical styles have made their appearance abroad. In Sweden the AB Tetrapak, for example, fills and forms a tetragonal container

from a continuous strip of plastic coated paperboard. In this country one manufacturer has recently introduced an improved pour spout which is designed for greater convenience in pouring. Further competitive developments in this direction can probably be expected.

Also in the dairy industry, market conditions affecting butter fat have placed increased emphasis on ice cream sales and a trend toward larger size consumer containers such as half gallons is being favored. The practice of counter filling bulk ice cream from 5-gallon pails has almost entirely disappeared along with the marble top table and wire chair drug store soda parlor. New institutional size 2½-gallon paperboard containers are being introduced to take the place of the 5-gallon pail, and a host of new types of consumer sized containers in the half gallon size are also available. The emphasis here is on speed in filling and economy of distribution so as to reduce the cost to the consumer, thereby increasing the volume sold.

The advent of large volume distribution of ice cream in paperboard containers has introduced some new carton protective considerations. Although not usually a problem because of a high rate of turnover and careful inventory rotation the possibility of ice cream deterioration by the loss of water vapor from the package has received some attention. Meiser of the Michigan Agricultural Experiment Station in a paper published in their *Quarterly Bulletin* of May 1950 has pointed out that significant losses occur from unwaxed or lightly waxed paperboard containers, due to water vapor transmission, which result in deterioration of the flavor and appearance of ice cream. The same results have also been obtained in unpublished work at our laboratory. We have found that ice cream in waxed cartons which do not have a continuous surface film of wax will lose weight and volume from two to four times as rapidly as those having a continuous film of wax on the inside surface of the carton. Consequently we believe that the future trend in paperboard ice cream cartons will be towards heavier waxing.

Frozen foods. Frozen foods are another product requiring the same type of packaging protection as ice cream. Last year the national consumption of frozen food was about 4 billion pounds. The breakdown of this total shows about 1 billion pounds for vegetables and something roughly in the neighborhood of 500 million pounds for each of the five other categories of: fruits, juices, meats, seafoods, and specialties. The retail value of these products was 1.2 billion dollars. Rough arithmetic establishes an average value of 35 cents/lb. for the frozen product. In spite of vigorous competition from fresh produce, the consumption of frozen foods is increasing and today regional delicacies which were relatively unknown a few years ago are widely appreciated and the public benefits from a more varied diet.

The most recent emphasis on new packaging for frozen foods is on liquid tight containers holding about 1 lb. net weight. For home freezing, the heavily waxed nested cup is being used extensively and for commercial packing the composite metal-fibre can is conventional. It is believed that there is a demand for still further improvements here. Cellophane lining for folding cartons once widely used for both dry and fluid products is now almost entirely restricted to fluid or semi-liquid products. Other fluid items such as juices, which were introduced in metal cans are moving experimentally towards film bags to some extent but apparently not towards paper.

Dry Items. For dry and free flowing items the waxed folding carton is widely used because of economy and speed of filling. The technical barrier problems which are presented by frozen food packaging have to deal with both liquid and gas transmission. In the first place an adequate water, or possibly also grease resistant, barrier is needed on the inside of the carton to prevent staining of the carton, sticking of the product to the carton, or loss of strength of the carton from absorption of water. In the case of products having aqueous juices, paraffin wax applied in a continuous film has now been found to be adequate and most economical.

Fried Products. In the case of fried or greasy products straight paraffin wax would offer little resistance to grease penetration. For moderate grease exposure, formulated waxes are available which are adequate grease barriers. For a superior grease barrier the use of greaseproof paper or a plastic film liner is necessary. These liners are usually laminated with microwax adhesive which, in addition to being a secondary grease barrier, is also a primary moisture barrier. Although they are not now being used for frozen food cartons, as far as we know, greaseproof plastic coatings would appear to be a promising future possibility.

Although a continuous film of paraffin wax on the flat panels of a frozen food carton forms an excellent water vapor barrier, the rupture of the wax film at the folded edges and the presence of gross atmospheric leaks around the closure of the carton makes it necessary to provide additional barrier protection if excessive dehydration during storage is to be prevented. Maximum storage times varying from 9 to 18 months must be provided for and it has been found that a good quality overwrap is the best solution to this problem. For speed in wrapping a heat sealing wrap is conventional and for reasons of utility and economy waxed paper has largely displaced cellophane as an overwrapping material.

Other developments in the field of frozen food packaging which can be predicted for the future are: First, reduction of the number of different sizes and shapes of consumer cartons. There are at present according to a recent issue of Quick Frozen Foods 50 different box sizes holding between 10 and 16 ounces of product. Second, higher speed setting up and filling machines. Within the last two years filling speeds have risen from a maximum of 100/min. to 180/min. and speeds as high as 300/min. are possible on some of the components now available. Third, increased use of the automatically set up glueless lock corner carton. Fourth, heavier waxing of cartons and less use of cellophane liners. This is a matter of economics. In a highly competitive market, excessive packaging costs must be eliminated. Here research will be called upon to provide sound technical bases for packaging budgets.

Individual packaging of frozen meats, poultry, fish. The individual packaging of meats presents another problem in the preservation of a highly perishable product. Packaging requirements vary depending on whether the meat is fresh, frozen or cured. Frozen meats, including fish and poultry, are vulnerable mostly to desiccation from loss of water and because of the relatively higher value of these meats, as compared to other frozen foods, more rigid precautions are generally being taken to insure against dehydration. The reason for this is that while minor dehydration of vegetables would be completely reversed in cooking, dehydrated regions of meats, fish, and poultry remain fibrous and unpalatable.

Recently a novel idea has been suggested for preventing desiccation in the packaging of frozen shrimp, which would allow a considerable reduction in the weight of the glaze ice now necessary to provide complete protection. Briefly, this idea contemplates deep freezing the shrimp first and then entirely surrounding them in the carton with a light coating of slush ice which will freeze on contact with the shrimp. Although with a package having a good barrier, desiccation losses can be minimized for unglazed headed shrimp, the flesh exposed at the head end still suffers some damage. The purpose of the slush ice glaze is to avoid even this minor degree of desiccation.

As long as frozen meats are held below 0° F., deterioration due to oxidation is not particularly significant, but for unfrozen meats the presence or absence of oxygen is an important factor affecting packaging. Fresh meats require the use of film materials which permit the free passage of oxygen so that cut surfaces will maintain a bright red color, while some cured meats are now being vacuum or inert gas packed to exclude oxygen. The preservation of fat meats such as bacon is also helped by the exclusion of oxygen which tends to cause rancidity. As with frozen meats excessive dehydration must also be avoided.

The role of paperboard in the packaging of fresh and cured meats at the present time is largely to provide a rigid frame for the package around which an appropriate transparent film is wrapped. This frame commonly takes the form of a pad or folder. In order to preserve good stiffness and a pleasing appearance, the paperboard should not be highly absorbent and should not be noticeably stained by blood or grease. Since complete freedom from blood and grease absorption is not ordinarily realized, the unavoidable staining is usually masked by a pink colored board in the case of meat pads or a white pigmented board in the case of bacon. The opaqueness of paperboard to light is also beneficial in retarding rancidity and color deterioration.

Baked products. In the packaging of bakery products, prob-

lems similar to that encountered with the fat meats are also met. Staining of the package by grease and oils is undesirable from the esthetic standpoint and also the grease which penetrates into paperboard suffers greater exposure to oxygen and goes rancid faster. The development of new and more economical grease barriers for bakery cartons is a problem which is being actively worked on by carton suppliers because some products which desirably should have a grease barrier cannot presently afford them because of the relatively low value of the product as compared to the cost of the greaseproof package. Plastic coatings, one potentially attractive barrier for this purpose, are still largely in the laboratory development stage. Although some plastic coated cartons are available commercially, the problem of obtaining a coating, at a competitive cost, which is sufficiently heavy to duplicate the performance of greaseproof paper under severe conditions has so far restricted the general use of these coatings. Nevertheless there is a good probability that a desirable plastic coated board for bakery cartons will be generally available in the near future.

Partially Cooked Items. The advent of partially cooked bakery items has also produced some new developments in paperboard containers. One of these products which is most familiar is "brown-and-serve" rolls. Brown-and-serve rolls, as the name implies, are composed of partially cooked dough which needs only to be heated in the oven for a few minutes to complete the baking process. Since the dough in these items is only partially cooked when packaged, there is a tendency in some cases for the dough to stick to the carton surfaces. Also, if the rolls are browned in the package, as is sometimes done, sticking to the package often results from the baking. Browning of the rolls in the package is not desirable, however, even if sticking has been eliminated, unless charring of the board is not a problem at required oven temperatures. Thus, there are three packaging problems here for which a solution is required either independently or collectively.

There are available at present treated glassines and aluminum foil liners for laminated cartons which largely eliminate sticking of the product as it is packed fresh in the carton and also eliminate sticking of the product when baked in the same paperboard package. These lined cartons have been used to some extent, apparently successfully, for bake-in-the-oven trays. The problem with using the paperboard carton as the oven baking tray, is, as has been mentioned above, the tendency of cellulose to char at baking temperatures. The rate at which this proceeds is a function of temperature and some products are now on the market for which baking in the carton is recommended. The success of this operation depends on preparing a product which can be browned quickly enough and at a low enough temperature so no off-flavor from charred paperboard will enter the rolls. Some danger exists, however, in that the housewife may not always follow the recommended baking conditions.

The status of these three problems at present, therefore, is that it cannot be generally recommended that the paperboard carton be used as the oven baking tray. Stickproof liners are available which are probably satisfactory for avoiding sticking of the fresh dough and in preventing sticking during baking. Thus the problem of the possible charring of the paperboard during the baking is the main obstacle to be resolved. In the interim some producers are packing the rolls in a separate aluminum foil tray which can be removed from the carton and used as the baking dish.

Another development in bakery packaging similar to that mentioned before for frozen food packaging is the increasing use of the automatically set up glueless lock-corner box which can be stored flat and set up rapidly at 100/min. One machine which has recently been introduced will set up a number of different styles and shapes interchangeably and requires less than two minutes to be converted from one tray size to another. Such machines fill an obvious need for packaging fresh bakery products.

Mixes. Proceeding from fresh bakery products, developments in the field of dry products such as cake mixes and dried fruits will be considered last. Here again adequate barrier protection against gain or loss of moisture is essential. Certain types of cake mix ingredients even come packaged in separate aluminum foil pouches placed inside the paperboard container. The packaging of dried fruits is also now more generally requiring a barrier carton. In the days when dried fruits were almost without exception stewed before eating, it didn't matter how dry, dry was. Today, however, where the emphasis is on ready-to-eat-from-the-package items the moisture content must be held within certain limits. If the moisture content is too low, the product is hard and unpalatable. If the product is packed with too high a moisture content, mold may develop during shelf storage and in any event, excessive loss of water might allow the net weight to fall below the labelled value. For the purpose of protecting dried fruits from moisture loss, barrier overwraps of various kinds are beginning to be widely used, therefore.

Cake mixes and dried fruits can be included together in a still further consideration of protective packaging—insect resistant packaging. These items are part of the class of foods subject to infestation by what are known as stored products insects. Although insect infestation of packages is not a critical problem in the United States the food industry is generally interested in possible developments on insect resistant packaging.

DEFENSE AGAINST INSECT INFESTATION

The first line of defense in protecting packages from insect infestation is tight sealing. Tight sealing keeps the crawling types of stored product pests from entering the package and also avoids attracting their attention by preventing the escape of attractive odors or sifting of the product out of the package. In addition, no insect attractive materials should be incorporated into the container itself in the way of glues, coatings or inks. Having taken these precautions, it is then possible that some further consideration of the application of insect resistant treatments to the container might be desirable. Although we are not aware of any published results of commercial applications of insect resistant treatments, it is believed that such treatments have probably been used at one time or another for special applications. As a result of experimental work carried out by our laboratory over the last several years, it is our opinion at this time that no general conclusions can be drawn regarding the need for, or efficacy of, any type of insect resistant treatments without sufficiently extensive field trials to establish statistical evidence of insect control.

It might also be mentioned that published results are available in the literature of the experimental work done by the U. S. Fish and Wildlife Service at their Denver station on the control of rodents by chemical treatments of packages. With the exception of a recently published instance of the limited introduction of Z. A. C. treatment on feed sacks, we are not aware of any present or contemplated commercial use of rodent repellent treatments.

SUMMARY

New developments in paperboard containers for food packaging have been greatly concerned in one way or another with the employment of the basic characteristics of paperboard containers in combination with new and better barriers. These basic properties are rigidity, durability and ease in handling, light weight, effectiveness for advertising display, and low cost. The various barriers developed have provided improved protection against the passage of water, water vapor, oxygen, loss of volatile flavors, the passage of oils and greases, and the entrance of insect pests. The successful development of these applications has involved technical considerations to a great degree and it is altogether appropriate that these problems should claim the attention of food technologists.

Problems in Handling Raw Commodities in Food Processing Plants[a]

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"Nothing endures," the first sentence in Cleland's textbook on "Physical and Historical Geology," applies with far greater emphasis to raw commodity handling practices in food processing plants than it applies to geological processes. The solution of one acute problem often creates one or more new ones and thus through a continuing succession of changes progress is made. Hence every handling operation eventually becomes a handling problem. Seeking solutions to these ever-present problems should not be left exclusively to those who make research their profession. Every employee should be encouraged to make suggestions for changes he believes will contribute to improved efficiency of the operation. An increase of 95,000 cases of pineapple juice a year is rolling off the production lines of a Hawaiian cannery as the result of a suggestion by a foreman in the juice extraction department *(4)*.

Since this discussion is to include anything that happens to a commodity from the time it reaches the processing plant until it is either heat treated, frozen, or dehydrated, the subject cannot be treated exhaustively. Only a few typical raw-material handling problems of the many in fruit and vegetable processing plants will be reviewed. The effort that is being put forward by various agencies to solve these problems, together with the varying degrees of success that have been attained, will be discussed briefly. The problems that need to be given consideration have to do with containers, conveying, quality appraisal, storage, conditioning practices, sorting, size grading, stemming, cleaning, peeling, trimming, pitting, and the urgent need for rapid handling.

CONTAINERS AND MATERIALS HANDLING EQUIPMENT PROBLEMS

Containers. Only three of the many types of containers in use for handling raw commodities will be mentioned. These are berry hallocks, and tote boxes for green beans.

Berry hallocks are thin plywood boxes. Placed a dozen in a wooden tray or "flat," they are used extensively in the Pacific Northwest to transport cane berries and strawberries from the fields to the processing lines. The perennial problem of the packers from the beginning of the berry processing industry has been to maintain a supply of clean, mold-free hallocks. Many attempts have been made to gain a solution to this problem with varying degrees of success. These have included treating with paraffin, wax emulsion, and other types of coatings with and without the use of a fungicide. Some processors steam their untreated hallocks after each use while others wash with cold water sprays whether the hallocks have been treated or not. However, many packers still neither treat nor wash their hallocks throughout the season. In such cases the hallocks usually are unfit for use long before the end of the season and are discarded.

California strawberry freezers have abandoned the use of hallocks. They use shallow wooden trays or "flats" instead. In some instances a new paper liner folded to fit the flat is inserted for each trip the flat takes from the field to the processing line. This insures the use of clean containers at all times without other treatment or washing.

"Tote bins" for handling green beans from the field to the cannery processing line are a most recent innovation that eliminates the use of packs and is said to cut handling cost *(1)*. The cube-shaped wooden bins of approximately four feet for each dimension hold 1,000 pounds of green beans. They are easily handled by fork lift trucks.

Conveying. This subject, including power equipment such as fork lift trucks, palletizing, various types of conveyors, and other modern means of moving raw materials from place to place in food processing plants, is sufficient for a long discussion by itself. However, this phase of handling is to be neglected except for a reference to water fluming and a caution against its use where serious leaching losses can occur.

Fluming is frequently used as a solution to the problem of conveying or transporting many fruits and vegetables in processing plants. It frequently serves a double purpose, as an aid to cleaning as well as an easy method of conveying. A means of "pumping" apples from the yard to the processing line has recently been described *(16)*. In most instances, as in the case of unpeeled apples, there is little or no danger of leaching losses in the fluming of raw materials. Raw cut corn is an outstanding exception where leaching losses are serious. Lindquist, *et al. (24)*, have shown that leaching losses resulting from fluming and washing raw cut corn can be greatly reduced by steam scalding or blanching the husked ears prior to cutting in preparation for freezing. They found that "It is possible to set up a line operation in which fluming can be completely avoided and contact of the kernels (after cutting) with water is reduced to a minimum." Their procedure produced a frozen product superior in flavor quality and considerably higher in total solids and total sugars. It also increased the yield of the frozen product from the raw material by 7.2 to 26.1%.

QUALITY APPRAISAL OF RAW COMMODITIES

The development of objective methods for the determination of the quality in raw commodities is continuing to receive attention of research workers and technologists.

Four considerations. There are at least four things that must receive consideration by the investigators in developing such methods: First, variable characteristics that have the greatest effect on the quality of the commodity must be known or determined. Second, definitions of grades based on these characteristics must be established. Third, the objective method to determine the relative quality of the raw commodity must be rapid. Fourth, the equipment used or developed to make the determinations must be relatively inexpensive.

Objective methods. Objective methods that quickly and easily appraise the maturity quality of cling peaches, sweet corn, green peas, and tomatoes will serve to illustrate what is being done in this important field.

The maturity quality of cling peaches is determined on the basis of flesh color. A colored plastic ring approved by the California Cling Peach Board in June, 1953, provides a convenient method for judging the minimum maturity for canning grades of choice and better.

Several rapid methods can be used to determine the quality of sweet corn to be canned or frozen. The moisture content has been well established as an index of the stage of maturity for

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most growing areas *(8, 17)*. Sweet corn grown in Western Oregon and Washington is an exception especially during rainy seasons. A reliable index of quality is being sought. Moisture can be determined quickly by the carbide weight-loss method *(39)*, electrical conductance *(17)*, or refractive index of expressed juice *(8, 17)*. The measurement of the volume of expressed juice obtained under standardized conditions *(21)* is another reliable procedure for judging the maturity.

The texture of the cotyledon of green peas has been recognized as the most obvious indication of maturity-quality from the beginning of the pea canning industry. A solution to the problem of objectively measuring the texture has not been so obvious. A number of methods *(23, 27, 31)* have been developed for measuring the stage of maturity, since the thumb and finger method was common practice. Of these, the tenderometer *(27)* has come to be universally accepted as the most practical by the canning and freezing industries, since its introduction in 1937.

However, there is one important problem that remains to be solved even with the tenderometer. That is to find some means of calibrating the instrument so that it can be easily determined whether any given tenderometer is giving readings consistent with that of an established standard.

The color grading of tomatoes, a rigid requirement in the tomato canning industry, can now be accomplished with at least two electronic instruments *(14, 37)*.

STORAGE

In general two types of storage are employed by processors to maintain a uniform flow of raw materials to the processing lines and to prolong the processing season. These are cold storage, where the fruit or vegetable is held in a predetermined optimum humidity range at a temperature often just above its freezing point, and freezer storage, where humidity is not usually a factor and the temperature is maintained at 0° F. or lower.

The optimum humidities and cold storage temperatures for all fruits and vegetables commercially processed in this country as well as the length of time it is safe to hold them are quite well established *(32)*.

The handling and conditioning of different fruits either prior to or subsequent to either cold or freezer storage are far more variable and provide a greater number of problems for research at the present time than do the requirements during the conditions of storage.

Peaches are harvested several days in advance of full maturity and should be ripened to within not more than one day of full maturity *(28)* before they are stored while pears are picked on a different maturity standard and ripened subsequent to the storage period. The cold storage of pears serves two purposes. It extends the processing season. In addition, cold stored pears soften uniformly when removed from storage. Frequently, uneven ripening occurs with untreated pears held at ordinary non-refrigerated ambient temperatures.

Freezer storage is commonly used to extend the processing of different kinds of berries packed with sugar in barrels or cans for subsequent manufacture throughout the entire year into preserves and jams. A limited amount of research conducted at the Western Utilization Research Branch during the war indicated that tree fruits such as peaches and pears could be held in freezer storage and subsequently processed into certain kinds of products *(33)*. However, it has not been determined whether freezer storage would be commercially practical for these fruits.

CONDITIONING PRACTICES

Conditioning includes methods for promoting a uniform maturity in the fruit for processing as is required for peaches and pears and the firming of full ripe fruit as is necessary in the case of sour cherries.

Maturity. There is still some disagreement among different canners and research workers as to the prime stage of maturity for harvesting peaches. Picking yield, handling qualities from the orchard through the processing line, wilting losses during handling and ripening, flavor, color and texture of the processed product are factors to be considered in determining the stage of maturity at which peaches should be picked for canning or freezing *(28)*.

The Bartlett pear canning season can be advanced from 10 days to 3 weeks, the minimum time they are held in cold storage, by the use of ethylene *(9, 10, 11)*. The so-called "hot" pears, those that arrive at the processing plant without the benefit of cold storage, frequently ripen so unevenly that one or more hand sortings are necessary at the beginning of the season to obtain fruit at the right texture stage for canning. However, "hot" pears can be softened uniformly in 4 days for fruit cocktail and 5 days for canning as halves if they are stored for these periods of time in an atmosphere containing a small amount of ethylene.

Ethylene will not hasten the softening of pears that have been in cold storage long enough for the conversion of starch to sugar *(10)*.

Firming. Another conditioning practice, in no way related to the maturation processes, is the firming of red sour cherries by soaking in tanks of cold water prior to pitting *(20, 38)*. Other purposes may be served at the same time, as soaking provides a convenient way of cleaning, cooling, and storing. Commercial practice in respect to the temperature of the water and duration of the soaking period varies considerably from plant to plant and in different sections of the country. Relatively little experimental data have been accumulated upon which to develop a standardized procedure.

MATURITY-QUALITY SORTING

The accomplishment of the vegetable plant breeders in recent years in producing varieties of baby lima beans with green seed coats on green cotyledons at full maturity has reduced inspection belt costs of removing white beans by hand, but it has produced two new problems. These are the development of standard specifications for frozen "green" baby lima beans and the design of plant equipment that will separate overmature beans and thus enable the processor to comply with the specifications.

One packer has solved the latter problem of quality grading, at least in part, even before the maturity standards are fully established. A large percentage of the dried and partially dried beans are removed by passing the raw beans through a nearly saturated brine separator after an initial washing. The brine is removed by passing the beans through another washer on their way to the blancher. They go through another quality grader after blanching.

SIZE GRADING

Many fruits and vegetables are size graded on the processing line. One example will be cited to illustrate one of several reasons for size grading.

Size grading of Brussels sprouts for freezing is important for the purpose of separating the raw materials into sizes that will permit adequate blanching of the large sizes without over blanching the smaller ones. This is especially important since it has been found recently that the pink to red centers sometimes develop in the larger sprouts as a result of insufficient blanching. Sprouts that are inadequately blanched are subject to quality deterioration while in frozen storage *(25)*.

A machine has been built *(35)* recently for size grading Brussels sprouts into 4 sizes.

CLEANING

The discoloration of the snipped ends of green snap beans, referred to as "black ends," has plagued canners and freezers from time to time. Opinions vary among processors as to the cause of the discoloration as well as means of preventing it. Mr. Joe Urschel of the Urschel Laboratories, Inc., after careful observation of many cannery operations has come to the conclusion that the pick-up of dirt by the snipped end and cut surfaces is the major cause of the gray to black discoloration while contamination from contact with copper will give an unsightly green color and iron will cause a rusty color. Dull snipping and cutting knives that tend to bruise while cutting and the accumulation of caked dirt under the snipper knives are contributing factors.

Green snap beans are not washed prior to snipping and cutting in most of the processing plants. The only washing is in the blanching and cooling operation. This is insufficient and has little control over the discoloration. Urschel says, "If the beans are thoroughly washed prior to the snipping operation most of the trouble with discolored ends will be eliminated."

Others think the cause of gray to black ends, at least in some instances, is due to oxidation of some natural constituent of the beans that is exposed to the air as the result of cutting and bruising in the snipping and cutting operation. Beans that are held for prolonged periods between picking and processing are believed by some to be more susceptible to discoloration than those that are processed promptly.

Wetting agents such as sodium alkyl aryl sulfonate are rapidly coming into use in cleaning many fruits and vegetables and to effect the removal of thrips from cane berries and aphids from broccoli.

Brekke *et al. (2, 7)* were able to obtain a reduction of 83 to 95% in the thrip count on cane berries by using 0.10% of a wetting agent (sodium alkyl aryl sulfonate) in wash water, whereas the reduction by conventional washing methods without wetting agents varied from 17 to 71%. The berries must be thoroughly washed subsequently to remove any residue of the wetting agent.

Detergents. The addition of detergents to wash water has been recommended *(19)* as an effective means of removing molds from fruit. A mold-count reduction up to 51% was obtained by washing strawberries in a forced immersion washer with a 0.10% solution of alkyl aryl sodium sulfonate and only 8% reduction in the same washing equipment without the detergent. A mold-count reduction up to 54% was obtained with the same detergent in a washer with a soaker tank and shaker spray in series and a 20% reduction in the washer with water and no detergent.

Two precautions are in order at this point: The potential user of detergents who considers adopting the method for the purpose of reducing the mold count should make sure that the washing process does not merely remove the objective criteria of decomposition but is effective in removing the decomposed material as well. The adoption of any process that does no more than remove the objective criteria of decomposition will invite condemnation of state and Federal food inspection agencies and may result in even more rigid means of control and enforcement. If the detergent or wetting agent is a toxic or deleterious substance it should not be added to any food product unless the process results in completely removing any possible residue by thorough washing.

The froth-flotation process developed by Neubert and Veldhuis *(29, 30)* for cleaning vined green peas is being used in removing corn borer larvae and ear worms from whole kernel corn; splits, pod pieces and debris from lima beans; in cleaning blueberries and in the removal of so-called "mummies" and debris *(18)*.

FINAL UNIT OPERATIONS PRIOR TO PROCESSING OR FREEZING

Stemming. The tedious job of hand stemming berries and other small fruits can now be done with a high degree of efficiency with a modified olive stemmer which in the past 6 years has completely eliminated the hand stemming of olives. Commercial use of the new machine for stemming grapes for fruit cocktail has demonstrated its efficiency and high capacity. Experimental runs with blueberries, currants and cranberries has proved it to be equally adaptable to these fruits. There is every indication that other fruits will be added to the list.

Peeling. There are at least 6 methods of peeling fruits and vegetables in processing plants. *Abrasion peeling* is used extensively for potatoes, beets, carrots, onions and other vegetables. *Flame peeling* has been tried commercially with varying degrees of success. It is being used for pimientos. *Lye peeling (6, 12, 15)* probably is employed for peeling more kinds of fruits and vegetables in larger volumes by more processors than any other method. *Mechanical machine peeling* is in common use for apples and pears. *Steam peeling* and *hot water scalding* are used rather extensively for some varieties of freestone peaches, peppers and tomatoes.

Tomato peeling. The common tomato peeling practice in most canneries has been to expose the tomatoes to live steam or boiling water from ¼ to one minute, depending upon their condition, followed by cooling with a cold-water spray or dip. The loosened skins are then removed by hand. Peeling losses from this procedure vary from 20 to 50% *(12)*. Tomato peeling methods and equipment are receiving special attention by some of the equipment manufacturers at the present time. One innovation is the use of a wetitng agent, superheated steam and a "scratcher." A recent tomato peeling equipment development employs hot combustion gases as the heating medium.

Trimming. The semi-automatic coring equipment, used for coring tomatoes, has been modified for trimming apples, artichokes, bell peppers, Brussels sprouts, cabbage, carrots, cauliflower, celery, figs and onions. A slightly different design of the machine, including the shape of the knives, has been made for each of these commodities. The rapidly rotating knives are driven by water pressure varying from 100 to 200 pounds p.s.i., depending upon the power required to trim the commodity for which the particular model is intended.

Pitting. Two rather novel pitting devices for cling peaches have appeared recently. One of these cuts the flesh of the peach to the pit with a tubular shaped knife after which the pit is driven out through the hole by the impact of a rod driven into the peach on the opposite side at a very high velocity. Suture positioning is not necessary. Except for the small plug that remains attached to the pit there is very little flesh clinging to the pit when it is removed. This completely automatic machine is used in pitting peaches to be diced for fruit cocktail or sliced for canning.

The other pitting machine *(36)* has a knife that cuts the flesh of the peach to the pit on the suture line and then frees the pit from the flesh by a twisting motion.

RELATION OF RAPID HANDLING TO ATTAINMENT OF QUALITY

Many of the fruits and vegetables that are canned and frozen are highly perishable in the raw fresh state. Rapid handling from the field or orchard through the processing line is the first essential for preserving top quality in these items.

The term "quick freezing," introduced by Clarence Birdseye *(5)* about 25 years ago, caught on very rapidly and did much to divert the public's attention away from the very poor reputation that previously had been established for frozen poultry, meat and fish as the result of careless handling and inadequate storage conditions.

It has since developed that there are several technological features in the harvesting, handling, processing and freezing of fruits and vegetables that are more important in the preservation of quality than the actual rate of freezing *(22)*, provided the freezing is rapid enough to prevent deterioration from enzyme action and growth of microorganisms. In fact there are three "quicks" essential to quality retention in many fruits and vegetables. These are *quick harvesting* when the fruit or vegetable reaches prime condition; *quick handling* from the field or orchard through the processing line; and *quick freezing*. The most important of these is the *middle quick, quick handling* from the field to the freezer.

Vined peas are more susceptible to quality deterioration during delay in handling and processing than perhaps any other of the items that are frozen. As a result considerable research has been done on the effect of delay on the quality of peas *(26, 34)*.

Time-Motion Studies (13) that are just beginning to find favor with some of the most progressive food processors give promise of improving plant operations and speeding up the production of the processing lines.

The Science Service Staff in their "1953 Science Review" of psychiatric and psychological research state that "It was demonstrated that production increases by more than a third when workers are grouped so that those who like each other are together." This should be especially worthy of note by management of handling and processing crews in food production plants.

CONCLUSIONS

Problems of handling raw commodities in food processing plants are many. For every one that is solved there are two others to take its place, as in all other fields of science and technology. This is a fertile field for research. Rapid progress is being made, however, and as a result a larger variety of food products with improved quality are being produced at lower cost.

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Concentrates for Lemonade[a]

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Concentrates for lemonade are discussed with special emphasis on the frozen product. The properties of concentrates and certain critical factors such as crystallization are considered. Taste discrimination work, the bacteriology of the product, and production problems are also included in the report.

Concentrate for lemonade, concentrated lemonade, and *lemonade concentrate* appropriately designate a class of lemon juice and sugar preparations whose compositions are such that mere dilution with potable water will produce a lemonade of desirable flavor, appearance, and body. Whereas such terms as *lemonade base* and *lemonade mix* have also been used in labeling such products; the industry has favored only those terms embracing the word *concentrate* in some form. The reason is that terms which include *concentrate* are familiar to the housewife through her earlier use of products such as concentrated orange juice, grape juice concentrate, etc.

Following the introduction of the frozen type concentrate for lemonade in 1949 and its rapid public acceptance, California processors formulated and adopted industry standards of quality as a measure to forestall competitive debasing of the product. They agreed that the term *concentrate for lemonade* was perhaps to be preferred to the alternative terms *lemonade concentrate* and *concentrated lemonade. Concentrate for lemonade* was the one term that carried the suggestion of need for mere dilution with water to achieve the end-product desired and yet conveyed no direct implication that the product was a lemonade which had been prepared as such and then subjected to a concentration by the evaporative removal of water.

From the standpoint of mode of usage, it seems entirely appropriate that these products should be designated and labeled as concentrated lemonades. The housewife knows, from the word *concentrate,* that the product need only be diluted with water for the preparation of lemonade. We would flatter ourselves in any assumption that she is interested, by and large, in the detailed technology of fabrication.

Furthermore, these products are concentrates as produced. Any substance or mixture, regardless of its mode of preparation, which is to be diluted out with water or with other inert ingredient to obtain a desired end-product, is in truth a concentrate of that end-product. The word *base* as applying to a food product to be diluted for use is familiar in the bottled beverage industry, for example, but is not generally known in the household. The designation, *lemonade mix,* is believed inadequate and inappropriate. Many existing grocery items are labeled and sold as "mixes." For the most part these are dry products requiring the addition of one or more major constituents such, for example, as milk or egg. In contrast, concentrates need only the addition of the inert and inexpensive diluent, potable water.

With issuance of United States Standards for Grades of Frozen Concentrate for Lemonade, effective December 19, 1953 *(8),* the product designation, *Frozen Concentrate for Lemonade* became official for labeling under these standards.

Because the individual steps in the processing of concentrates for lemonade follow in principle the conventional citrus juice handling methods, this paper omits details of general processing and control work and aims rather at emphasizing aspects peculiar to lemon processing and to the products under discussion. Although current interest centers around the frozen product, a few remarks regarding its precursor, the hot-packed variety, may be apropos.

HOT-PACKED CONCENTRATE FOR LEMONADE

The idea of preparation, for sale, of a concentrated product to be diluted with water by the consumer for preparation of a lemonade is of course not new. The earliest commercial production of a hot-packed concentrate for lemonade appears to be, so far as we are able to ascertain, that of our company in 1938, when small-scale production was undertaken for a co-packer whose sales were primarily to drug stores in the 46-oz. can for dilution and dispensing as lemonade at the soda fountain, with a smaller amount being packed in the 8-oz. size for retail trade.

In the light of present practice in the frozen concentrate field the composition and properties of this early hot-packed item are of interest. The product was essentially a solution of sucrose in an equal weight of fine-screened single-strength lemon juice with a citric acid content of 60 g. per liter or somewhat above, resulting in a concentrate with a Brix value of about 59° and a Brix-acid ratio of approximately 18:1. It carried 0.1% sodium benzoate and about 0.02% by weight of a 5-fold concentrated lemon oil. It was strictly a fine-screened juice product with no coarse pulp or juice sacs present. The finished product was de-aerated, flash pasteurized, and hot-packed in citrus enamel-lined tins by the chock-fill method. Sealed tins were chilled in refrigerated water and cased goods were kept in cold storage. The product was intended for dilution to 6 volumes (1 plus 5) and on this basis the beverage had a Brix value of about 12.3, citric acid content of slightly below 0.7% and a Brix-acid ratio of approximately 18:1.

The hot-packed products of today do not differ basically from this original version, but as a class these products differ from the frozen concentrates in several important characteristics. In the first place they must be substantially free from coarse pulp or juice sacs and of low natural oil content in order to achieve any reasonable flavor quality retention during storage. The freshly made product yields a lemonade of pleasing and acceptable taste quality, differing, however, from a true fresh lemonade flavor as a joint result of the heat treatment involved in the de-oiling and pasteurization and the presence of a concentrated lemon oil. The product must be thoroughly deaerated

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after sugaring and prior to hot-packing. Use of plain tin cans is ruled out because of rapid development of an astringent or "tinny" off-flavor, especially after the product leaves cold storage. A darkening in color accompanies the gradual off-flavor development during storage in citrus enamel-lined tins and may be very marked after exposure to shelf temperatures during warm weather.

At cold storage temperatures of around 40° F. the original flavor seems unimpaired for approximately 3 to 4 months. Samples stored for up to 3 years have been judged still palatable, but with a definite "enamel" off-flavor and a noticeable darkening in color. In contrast to this the normal shelf life after leaving refrigerated storage is approximately 6 months and top flavor quality is lost in about 30 days.

FROZEN CONCENTRATES FOR LEMONADE

The first commercial-scale production of frozen concentrate for lemonade of which we have record was of Pict-Sweet Brand, packed by the Damerel-Allison Company in 1949. From this start the California production had reached about 7 million cases (24/6-oz. equiv.) by the year 1953, with an output of about 10 million cases anticipated for 1954.

Raw materials. Lemons and sugar constitute the required raw materials for preparing a top quality frozen concentrate for lemonade, meeting all existing standards.

Fruit supply. In point of fruit supply for the juice component the lemon products industry is in a rather unique position in several respects. In the first place, and for the time being, the bona-fide high acid type of lemon required is grown in commercial quantities only in one area of the U. S.—namely, Southern California and portions of Arizona. In the second place, the fruit is picked all year around. About two thirds of the annual crop is picked during the spring and summer months when demand for lemons and for lemon juice products is highest. The remainder is packed during the fall and winter months. The seasonal variation in quantity of lemons available for juice products use does not imply fluctuation in fruit quality, nor in suitability of the juice for beverage products manufacture. Fruit of excellent quality is normally available throughout the year.

The lemon tree differs from orange or grapefruit in that all of the major high-acid varieties in this country—namely, the Lisbon, Eureka and Villa Franca—bloom and mature all year round, and the fruit reaches commercially desirable sizes in about 7 or 8 months.

The 3 varieties of lemons mentioned above do not differ appreciably in juice flavor, are practically indistinguishable, and are not sold or processed separately, as is the case with the varieties of most other species of citrus fruits. Relatively minor differences in the juice and acid contents of the 3 varieties mentioned have been reported by Batchelor and Bitters *(2)*.

Because the lemon products industry is still intimately tied to fresh fruit production and sales, lemons are not as yet grown in this country primarily for products outlets. The supply available for products manufacture is, on the contrary, the cullage and surplus of the fresh fruit operation.

Unless crop or fresh fruit market conditions dictate a deviation, lemons are normally picked according to size, and the successive pickings of a grove may be at intervals as short as only a few weeks. Fruit for products culled out at the fresh fruit packing house washers includes that which is fully ripened as well as scarred, blemished, deformed and under- or over-sized fruit. A second diversion to the products plant use takes place when the cured fruit is taken from storage for re-grading and packing for fresh fruit shipments.

It is to be noted that lemons are not normally allowed to ripen to a full lemon color on the tree. This is another peculiarity of the lemon industry, and one which may lend, perhaps, more fiction than fact to the advertising phrase, "Made from choice tree-ripened lemons!" Conventional standards for maturity of citrus fruits, normally based upon Brix-acid relationships, do not apply, however, in the case of lemons. The only existing official maturity standards for lemons relate to fresh fruit shipments and state that the juice yield must be not less than 25% of the fruit volume.

Details of the picking, packing house handling, and of the ultimate grading of fruit for use in lemon juice products, have been reported by Baier and Stevens *(1)* and, as these authors point out, top quality fruit for juice products requires the careful grading out of all fruit defective in any respect which affects the flavor quality of the juice.

Lemon juices. Lemon juices are utilized on the basis of their content of anhydrous citric acid. Values for juices extracted by conventional burring and similar methods have been found over the years to average close to 60 g. per liter. It is lower for juices obtained by macerating or grinding and by methods of expression if the latter be drastic enough to introduce peel water into the recovered juice. Whereas 60 g. per liter is an average, values ranging from 45 g. to as high as 75 g. per liter are occasionally encountered, due to seasonal, climatic, cultural and other reasons. To complicate matters, the Brix value of a lemon juice does not bear a linear relationship to the acid content. Concentrated lemon juices, therefore, taken either to a specified Brix value or to a definite volume concentration, such for example as 5 : 1, would be highly variable in acid content and general utility.

Production and sale of concentrated lemon juices on a specified citric acid content has become the predominating practice without regard either for Brix value or for actual volume: concentration ratio. The high degree of variability in acid content of the single strength juice has had to be considered in establishing satisfactory formulas for lemonade products.

The juices taken as an ingredient of the frozen concentrates for lemonade differ from the conventional fine-screened lemon juices of commerce in that a considerable portion of the natural content of juice sacs and of relatively fine pulp particles normally screened out are either left in the juice or are separated and later reincorporated to impart a pulpy appearance to the final lemonade. This practice is commented upon in a later section.

Sweetening agents. In the California industry to date the only sweetening agent used extensively has been sucrose, although any suitable nutritive sweetener is permitted. Granulated sugar is employed in all but one establishment; incidentally, bulk handling is rapidly eliminating the use of bags. The one user of liquid sugar employs the 66° Brix sucrose sirup. Use of liquid sugar automatically puts an upper limit on the ratio of single strength to concentrated lemon juice that may be employed, for the reason that the average concentrate approximates in basic composition equal weights of sucrose and high acidity single strength lemon juice. If water is to be added with the sugar, an equivalent amount of water must be removed from the juices employed. Whereas use of dry sugar normally permits adding of as little as 10% of the total acid as concentrate, use of 66° Brix sugar sirup requires concentrate equivalent to about 50 to 60% of the total acid in the product. These are disadvantages that may more or less offset the advantage of convenience in processing which liquid sugar presumably offers. Experimental work underway at several laboratories is exploring the partial substitution of the hexoses such as dextrose, invert sugar, etc. for sucrose.

Containers. Approximately 93% of all production of the frozen concentrate last season was packed in the 6- and 12-fluid-ounce sizes for home consumption. The 12-ounce size is gaining in popularity as a consumer package; the 46-ounce size finds favor for institutional use. Steel drums of 55-gallon size, with polyethylene liners, have been packed and shipped in quantity for further processing and/or repackaging.

Citrus enamel-lined tins have been used almost exclusively in the hermetically sealed packs, but this seems to have been largely in deference to housewife preference. Our observations during the past few years, confirmed by unpublished reports of other laboratories, indicate no choice as between a good grade of tinplate and inside citrus enamel.

Packaging of concentrate for lemonade in small flexible pouches of the laminated polyethylene-cellophane type has been pioneered by our company in cooperation with the Standard Packaging Corporation, on a restricted scale, and primarily for a product to be reconstituted and dispensed at the soda fountain. Historical and developmental aspects of use of flexible packages for both orange and lemonade concentrates are described in a cur-

rent paper by Fehlberg and Holbrook *(5)*. The keeping quality of the lemon product in these laminated containers is excellent. The one trouble encountered, that of crystallization, appears to be due to no inherent fault of the packaging material. It is commented upon later in this paper.

Processing notes. California standards require that only nonpasteurized juices be used in frozen concentrates for lemonade, and that any processing of the juices employed must be at not above 80° F. A recent survey of methods employed by the major processors reveals the following:

Juicing equipment used includes the Brown, Food Machinery Rotary, Citromat, and Bireley types. Paddle finishers and rotary type screens predominate but screw-type finishers and shaker screens are also in use. Fine finishers are predominately equipped with screens of about 0.02 in. opening. Blending, sugaring, and standardization are carried out in lots ranging from 300 to 1000 gallons in size. Both cold-wall and jacketed refrigerated stainless steel processing tanks are used, maintaining temperatures of 40° F. or below. A common but not universal practice is to apply a moderate vacuum after addition of the dry sugar and while final checks are being run, to effect a partial removal of air entrapped during the burring and finishing steps and during the addition of the sugar. Moderate amounts of residual air appear not to affect adversely the keeping quality at the intended storage temperatures of zero or below, and while complete removal of air would be difficult if not impossible of attainment, it is not unlikely that near complete removal might be actually deleterious in view of the high amounts of unpasteurized pulp and tissue material present.

Votators are used in about 50% of the plants for further chilling the feed to the fillers. Filling temperatures range from 15 to 25° F. Piston type fillers find preference in most plants as does also the steam-flow method of evacuating the head-space. Final sharp freezing is by air-tunnel in the majority of establishments, but two plants use the submersion method with methanol or with isopropanol-acetone mixture as the chilling medium. Air tunnels operate at from —10 to —40° F.; submersion baths are held at from about —25 to —40° F. Product temperatures range normally from +10 to —10° F. out of the freezer. Frozen storage rooms are held at temperatures of from 0° to —10° F.

CONSTANTS: FROZEN CONCENTRATES FOR LEMONADE AND THEIR BEVERAGES

Our laboratories recently surveyed constants for some 30 brands of concentrate for lemonade (Table 1). All products were for consumer use, mostly in the 6-fluid-ounce pack using standard 202 x 314 I. C. E. tins, and all intended for reconstitution on the conventional basis of 6 ounces to yield one quart of lemonade (1 + 4.33). The mean average formula for a thousand-gallon batch (Table 1) represents general industry practice except where liquid sugar is employed or, for some other reason, where higher proportions of concentrated lemon juice are used. The ranges shown for constants cover practically all commercial packs currently on the market.

TABLE 1

Concentrates for lemonade, and their reconstitutes
Ranges and Mean Values of Constants

Constant	Concentrates for Lemonade		Lemonade [1]	
	Range	Mean	Range	Mean
Brix	48.5 –55.7	52.1	10.66 –12.56	11.61
Citric Acid Anhyd. % (W/W)	3.06 – 3.58	3.31	0.69 – 0.79	0.7
% (W/V)	..... –	.....	0.72 – 0.82	0.77
Brix: Acid Ratio	14:1 –18:1	16:1	14:1 –18:1	16:1
Pulp, %, (Vol. + 20 mesh)	1.5 – 4.0	2.75	..... –	.....
Recoverable Oil % (Vol.)	0.028– 0.066	0.047	0.005– 0.012	0.0085
pH	2.3 – 2.4	2.35	2.5 – 2.6	2.55
Juice Content % (Vol.) (@ 60 g. Anhyd. Acid/L.)	..... –	.....	11.7 –13.7	12.7

Mean Average Formula [2]

Single Strength Juice @ 60 g. Anhyd. Acid/L)	570 Gal.
Pulp Slurry—50% + 20 mesh	55 Gal.
Conc. Lemon Juice (@ 325 g. Anhyd. Acid/L)	11 Gal.
Sugar	4,851 Lbs.

[1] All values for lemonades proper, and excepting pH, are calculated.
[2] The formula shown is for a thousand-gallon batch.

Properties. The average composition around which the constants center (Table 1) is a very fortunate choice. Use of small but variable amounts of concentrated juice not only permits adjustment to any desired degree of tartness, but also maintains uniformity of acid content in spite of the normally encountered variations in acidity of the single strength juices available. Any desired change in beverage sweetness, tartness, or body may be effected without change in fill, can size or reconstitution ratio, and without resort to use of any high proportion of concentrated juice. Sugar solubility is such that holding of the blended juices at as low as around 35° F. while incorporating dry sugar entails no trouble or delay in effecting solution.

The fact that constants are such that a standard 6-ounce tin provides a quart of lemonade is a convenience in use, as is also the fact that the content of a 6-ounce can may be either diluted to a measured quart or reconstituted by addition of an even four full cans of water. The semi-solid consistency of the product at usual frozen storage temperatures insures ease of removal from the can and rapid reconstitution. The composition permits use of liquid forms of sweetening agent by merely increasing the ratio of concentrated to single strength juice employed. The usual 6-, 12-, 46- and 128-ounce fills in standard tins occasion no trouble with can bulging at frozen storage temperatures.

As to storage life, samples have been observed for periods of as long as 3 years at 0° to —10° F. In all cases flavor quality was unimpaired to any extent that could reasonably be expected to affect consumer acceptance and satisfaction. There was no indication of darkening or gelation. Reconstitutes showed no flocculation or separation that would be noticeable in normal usage.

After frozen storage and transfer to refrigerator temperatures, the product remains of good taste quality for as long as 45 to 60 days, and the reconstitute exhibits no significant flocculation or separation. A slight change in flavor, described as a tinge of mustiness, becomes noticeable within about 2 weeks and a slight lime-like flavor may be apparent after about a month due to changes in the oil component.

CURRENT STANDARDS

In November, 1950, the major processors formed a technical committee to formulate industry standards for lemonade preparations. It was hoped that these standards would serve the interests of the buying public, the lemon industry, and the processors themselves by establishing tolerances for those factors which determine quality. The committee was made the official Technical Advisory Committee of the California Lemon Products Advisory Board in May, 1953.

The standards evolved by this committee became State standards on October 15, 1952, under the California Marketing Order for Lemon Products; they were amended as of July 3, 1953, with respect, particularly, to the frozen types of concentrate for lemonade.

As of April 18, 1952, Interim Federal Specifications were issued, covering the frozen product *(6)*. United States Standards for grades of frozen concentrate for lemonade were issued December 19, 1953 *(8)*. Space does not permit full discussion of these existing standards, but the salient features may be briefly set forth, referring only to the frozen product, since both the P.

and M.A. grade standards and the Interim Federal Specifications relate only to this type.

It should be pointed out that the original industry-favored and sponsored idea of having tolerances placed upon the lemonade beverage itself rather than upon the concentrate, has been adhered to in the Federal Specifications and standards which have been issued to date, and in the California state standards. The Standards define lemonade and class as concentrate for lemonade any product which, upon dilution with potable water in accordance with the directions accompanying the product, yields a beverage meeting the standards for lemonade. This permits varying the composition of the concentrate proper to suit the requirements of various consumer, institutional, and industrial use without need for any change in existing standards. At the same time it does not stifle technologic advances that may ultimately take concentrate for lemonade to the dry-solid state.

Frozen concentrate, in order that its properly prepared reconstitute shall be a lemonade in compliance with all existing standards, must contain lemon juice and sugar. It may contain concentrated lemon juice, lemon oil in one form or another, and potable water as required for standardization. All juices employed must be from the high acid varieties of the lemon fruit.

All standards permit choice of sugars to be used; all permit use of added lemon oil or its concentrates, extracts or emulsions; and all permit presence of pulp particles and juice sacs, and of seed particles if size and quantity of the latter are not excessive.

California standards permit not less than enough lemon juice to impart a minimum of 0.7 g. anhydrous citric acid per 100 ml. of lemonade. This limit obtains also in the P. and M.A. grade standards for both Fancy and Choice grades, whereas the interim Federal Specification *(6)* permits acidity as low as 0.6 g./100 ml. in the "Grade B" or "Choice" category. Both Federal standards establish an upper limit of .02% recoverable oil in the beverage of the Grade A product and .03% in that from the Grade B.

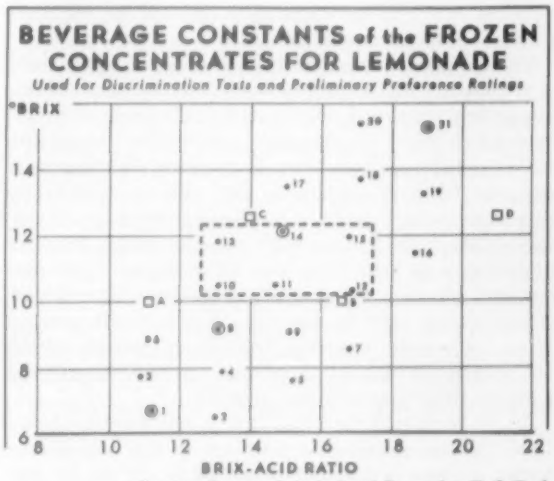
The California standards and the P. and M.A. grade standards both require that freshly prepared or frozen single-strength lemon juice shall in no case account for less than 20% of the total acid present in the product. The interim Federal Specification *(6)* implies, but does not explicitly state, that concentrated juice shall be limited to the amounts necessary for adjustment of the acidity. None of the existing standards currently permit use of added preservatives.

B. A. E. discrimination tests. Table 1 indicates a rather wide spread in values for Brix and Brix-acid ratios. Similar observations during the first year or so of production prompted general comments within the industry to the effect that Brand "X" would never sell, except possibly as a mixer, because of being too tart and that Brand "Y" would be relished only by children because it was much too sweet. This state of affairs ultimately proved to be a classical example of the proverbial folly of letting technicians and other experts attempt to pass judgment in behalf of the consuming public.

In 1951 the Lemon Products Advisory Board made arrangements with the Division of Special Surveys, Bureau of Agricultural Economics, U. S. D. A. for preliminary preference rating tests as a prelude to contemplated large-scale market tests. The necessary discrimination tests were completed in 1952 under the direction of Forrest E. Clements, Head of the Division, and results were reported by Bayton and Bell *(3)* in September 1952. The frozen concentrates for lemonade for this work were prepared in California and forwarded to Washington for reconstitution and taste testing. Extremes in beverage Brix and ratio values were deemed advisable in these exploratory tests, but oil and pulp contents were maintained constant.

This excellent piece of work yielded surprising results. It was found that a taste panel of adults was not able to discriminate positively between the sweetest and the most tart products on the market. Figure 1, reproduced from the B.A.E. report, portrays the ranges and combinations of Brix value and Brix-acid ratios of the first 21 samples of beverage used in the discrimination test work. The encircled dots represent the closest combinations of Brix and Brix-acid ratios that were mutually discriminable using 36 samplings of each pair in the series and the duo-trio procedure on adult subjects. Correct judgments of 67% or better were assumed necessary to prove discrimination. The broken-line rectangle in Figure 1 embraces the extremes in lemonade constants that would result from reconstitution of any of the commercial concentrates then on the market. With a second series of 4 samples, indicated as samples A, B, C, and D in Figure 1, these investigators found that sample A, for example, was discriminable from sample D but not from samples B and C.

The data indicate that differences which seem marked to the skilled technician are not subject to positive detection by the consumer. Unless there is reason to contemplate a general shift in the entire area of constants now considered commercially feasible, consumer



—Courtesy Bureau of Agricultural Economics, U. S. D. A.

Figure 1. Preliminary discrimination tests on Brix and Brix: acid ratio variations.

preference tests had perhaps best be confined to factors affecting flavor or appearance other than Brix and Brix-acid ratio, such for example as fruit quality, oil content, and pulp level.

The pulp content. The mean "pulp" contents, so-called, of the frozen concentrates for lemonade now on the market range from 1.5 to 4.0% by volume, as determined on the concentrate itself. Since this range covers the optimal values specified by the various processors and buyers, and since a tolerance must be allowed in the specification, an extreme range of about 1.0 to 5.0% actually prevails.

Quoting of per cent pulp content is based upon the concentrate; the common but not universal practice is to specify pulp content as the per cent by volume of wet pulp retained on a Tyler Standard 20-mesh wire. This method is generally preferred to a determination by weight because it is simpler, more rapid, and requires only volumetric equipment. In a few cases pulp is still specified either as per cent by weight or in terms of grams of pulp per can of product.

The material referred to as pulp consists in the main of fragmented juice sacs with smaller amounts of relatively fine pulp and rag particles. Inclusion of this material in juices for lemonade concentrates began with the introduction of the frozen product. It apparently stemmed from the desire to add richness and fruity character to the appearance of the final beverage. Particles of desirable size for this purpose readily pass the first screen or coarse finisher following the juice extractors. This is conventionally a perforated screen with approximately 0.09 in. openings. It effectively removes seeds, large seed fragments, and coarse particles of pulp and rag while passing juice sacs, mostly fragmented, with the finer pulp and rag particles.

In production of the usual type of fine-screened lemon juice the coarse screen is followed by the fine finisher with openings of about 0.02 in. Recovery of the pulp desired in the lemonade products may be accomplished by allowing juice from the first finisher to repose in a tank long enough for most of the desired pulp to rise to the top. There it may be removed fairly free from seed fragments, heavy pulp particles, and extraneous matter. These settle to the bottom, are removed with the outgoing juice, and are then discarded by the second or fine finisher.

A simple, effective and continuous method of recovery of this pulp has been developed by our laboratories, employing the equipment units illustrated in Figures 2, 3, and 4. The pulp slurry recovered by this equipment is relatively free from objectionable seed particles, specks and extraneous material, is of improved uniformity of particle size, and is delivered at a uniform predetermined pulp content to a holding tank ready for volumetric addition to batches of concentrate in preparation.

Figure 2 shows the flow of juice from the coarse screen or finisher to the bottom of the deaerating tube, which serves to release entrapped air if the feed is by direct pump from the finisher. It is then fed tangentially into the lower part of the separator tank past a deflector

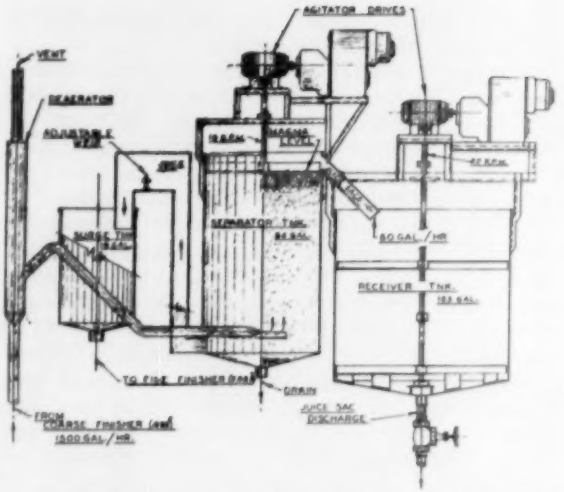


Figure 2. Continuous pulp (juice sac) separator. Exchange Lemon Products Company.

plate which forces the incoming juice upward and away from the juice overflow outlet which is also at the bottom of the tank's sidewall. The deaerating tube or a surge-tank type of feed is essential in preventing disruption of the separated pulp slurry or cake in the top of the separator by rising air pockets, which would reincorporate juice and cause the slurry discharge to become too thin. As the juice passes upward the light pulp particles, aided by remaining fine entrapped air bubbles, collect at the top while the relatively denser seed particles, etc. settle into the cone bottom. No agitation is employed and a motor driven "S" shaped blade at the top diverts the thick pulp slurry into the outlet trough at the top and thence into the receiver tank. The pulp content of this slurry is regulated by adjustment of the overflow weir height. Lowering of the weir will increase the pulp content of the slurry collected by allowing more time for the heavy slurry at the surface of the separator to compact and be elevated to the level of the pulp dis-

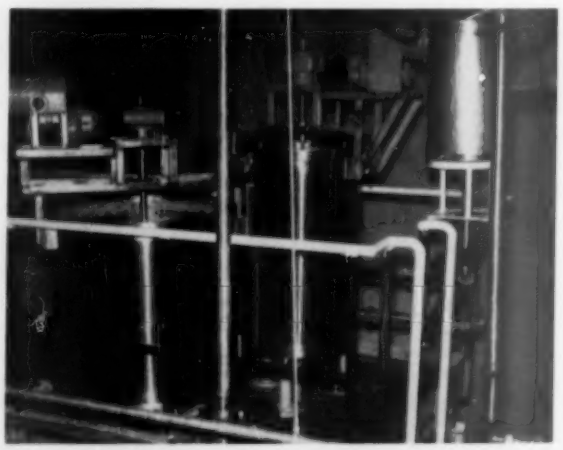


Figure 3. Continuous pulp separator unit. Exchange Lemon Products Company.

charge blade. Juice over this weir enters the discharge surge tank and constitutes the feed to the fine finisher. The pulp receiver tank is equipped with slow moving agitator blades to maintain uniformity of slurry.

In terms of per cent pulp by volume retained on a 20-mesh screen the unit will deliver pulp slurry of from 50 to 90% pulp content at maximum juice inputs of about 1500 gal./hr.

In Figure 3 a closeup of one of the units is shown; in this unit the deaerator tube is replaced by the small juice input surge tank shown in the upper right-hand corner. This tank, with open feed at the top and with bottom outlet, effectively eliminates delivery of entrained air pockets to the separator tank. In Figure 4 is seen a battery of 2 separator units capable of handling together the average output of about 28 Brown extractors.

Figure 4. Battery of pulp separators on mezzanine of tiled burring room. Exchange Lemon Products Company.

With average fruit and moderate burring pressures the pulp content of juices from the first finisher will range close to 8% by volume (retained on 20-mesh test screen). Recovery in the pulp separators averages approximately 50% so that the yield of good quality pulp for incorporation in lemonade products averages about 4% of the juice input volume or about 60 gallons per unit per hour as a maximum. If the unit is adjusted to deliver a slurry carrying 50% pulp retained on 20-mesh, the yield is obviously about 120 gallons per hour, and 2 gallons of the slurry must be used for each gallon of pulp required in a product formula.

The average concentrate for lemonade approximates two-thirds juice and one-third sugar, by volume. A 1000-gallon batch will therefore require about 650 gallons of juice during preparation of which about 4% of that volume, or 24 gallons of pulp are recoverable. This would suffice to impart a pulp content of 2.4% by volume to the 1000-gallon batch of concentrate. Whereas this figure is less than the 2.7% pulp content shown in Table 1 as the mean value for practically all brands on the market, it coincides closely with the actual average value for the industry because the majority of brands prefer a pulp content of about 2%.

Sugar hydrate formation. In view of the report by Olsen and Moore *(7)* on sugar hydrate formation in frozen sugared grapefruit concentrate and in frozen limeade, the following observations may be of interest, especially since they appear to confirm the conclusion of Young, Jones and Lewis *(9)* that causes and effects of sugar hydrate formation must be investigated for each specific product in question. They also confirm, in general, the observations reported by Brekke and Talburt *(4)* in 1950.

Our experience in the packing and in the storage of many brands of concentrate for lemonade, together with a recent survey of all major processors in California, reveals no trouble with this crystallization in hermetically sealed tins of the product. Brix values range from about 48 to 56 degrees, pH values hover close to 2.35, and storage is normally at 0 to —10° F. Sucrose has been the only sugar used.

In the early experimental packing of a similar product in flexible laminated pouches it was observed that after a relatively short storage period at 43° Brix and at —10° F., occasional packages showed definite signs of localized crystallization. Suspicion as to the cause was aroused when we deliberately thawed the pouches which showed this effect. Our intent was to learn how much the "fondant" formation might affect ease of reconstitution, but something of greater interest was revealed; namely, in every instance the affected package was a leaker. The trouble was not due to any fault in the polyethylene-cellophane laminated film but rather to faulty automatic sealing and to inadequate care in handling during the freezing and casing operations.

Observations on crystalline growth. Experimental work has permitted the following observations which confirm the findings of earlier workers with other sugared products and are therefore new only as they pertain to sugared lemon juices. The slightest rupture, opened seal, or pinhole in the film causes the "fondant" formation, presumed to be hemi-hydrates of sucrose, in a relatively short time at —10° F. Crystallization starts at the point of air access and progresses both along the surface and internally, eventually transforming the entire content of the package. Packages devoid of the imperfections mentioned above have shown no signs of crystallization of this type during a period of over a year at —10° F. Variations in Brix of the product from 43 to 54 degrees appear not to alter the rate nor extent of fondant formation appreciably.

Storage samples held for 3 months at —25° F. have shown no such crystalline growth in either ruptured or sound pouches, confirming the observation of Brekke and Talburt *(6)* that —10° F. seems optimal for the phenomenon. Transfer of affected samples at —10°, to storage at —25° seems to arrest the growth completely. In Figure 5, samples 1 to 4 are perforated pouches while samples 5 to 8 are sound. All samples are of 43 Brix concentrate for lemonade, excepting numbers 4 and 8 which are of 41° Brix orange juice concentrate. Storage time was 3 months. Samples 1 and 5 show no fondant formation in concentrate for lemonade at —25° C. Samples 2 and 6 show the characteristic crystalline growth at —10° F. in sample 2, with none apparent in the sound package, No. 6. Sample 3 shows the retarding effect of 20% cerelose replacement of sucrose in a perforated pouch, while sample 7 is a control in a sound package. Samples 4 and 8 show no tendency for crystallization in the case of the conventional 41° Brix orange concentrate.

The effects of substitution of varying amounts of cerelose for sucrose during storage of 43° Brix lemonade concentrate for

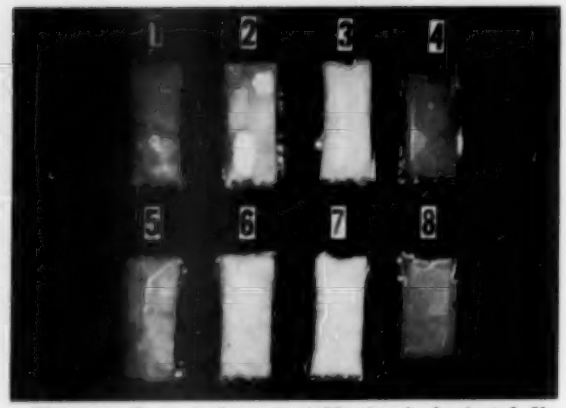


Figure 5. Sugar hydrate crystallization in laminated film pouches during 3 months storage.

No. 1—Conc. for Lemonade, 43° Brix, Sucrose only, Imperfect Pouch, @ —25° F.
No. 2—Conc. for Lemonade, 43° Brix, Sucrose only, Imperfect Pouch, @ —10° F.
No. 3—Conc. for Lemonade, 43° Brix, 20% Cerelose, Imperfect Pouch, @ —10° F.
No. 4—Conc. Orange Juice, 41° Brix, Non-Sugared, Imperfect Pouch, @ —10° F.
Nos. 5, 6, 7 and 8—Controls, respectively, in sound pouches.

2 months at —10° F. are shown in Figure 6. Samples 1 to 4 are in perforated pouches, while samples 5 to 8 are controls, in sound pouches, of the sample directly above in each case.

Samples 1 and 5 are of a straight sucrose composition while cerelose substitution for sucrose was made to the extent of 20% in samples 2 and 6, 40% in samples 3 and 7, and 60% in samples 4 and 8.

During this short storage period increasing proportions of cerelose seem beneficial in retardation, but not in prevention, of fondant formation up to about 40% substitution. Under the same conditions, use of as high as 60% substitution of cerelose is disastrous in that crystallization is markedly accelerated at this cerelose level, presumably due to glucose hydrate formation, and proceeds whether contact with air is permitted or not.

Investigation of other sugars as partial substitutes for sucrose is under way. Although the trouble appears only in imperfect packages, these will inevitably be encountered due either to an occasional imperfect seal or to damage in packing and transit. It will be highly desirable to reduce the effect to a minimum.

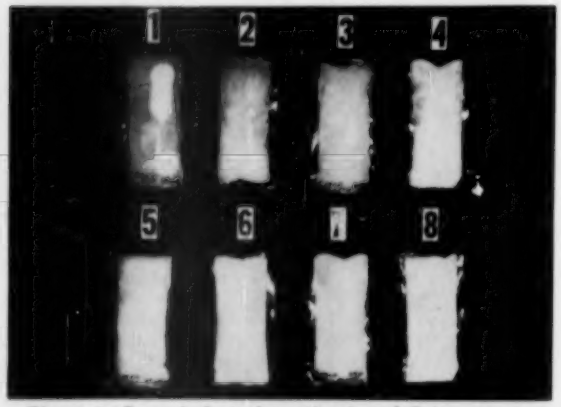


Figure 6. Sugar hydrate formation in 43° Brix concentrate for lemonade effects of varying substitutions of cerelose for sucrose, 2 months at —10° F., in laminated film pouches.

Nos. 1, 2, 3, and 4, in imperfect pouches, represent, respectively, 0, 20, 40, and 60% substitution of cerelose for sucrose.
Nos. 5, 6, 7, and 8 are corresponding controls in sound packages.

The hypothesis of presence of sucrose hemihydrate seed crystals in the air, suggested by earlier workers as a possible explanation of this phenomenon, seems substantiated in our meager observations to date. This likelihood seems even more probable in view of the fact that slit pouches of the same identical product, placed in storage in different freezer boxes or cold rooms at —10° F. or in the same location on different days, show first fondant formation much more quickly in some instances than in others. Occasional lots of samples show as much of the effect in a few days as other lots do after several weeks. It is quite unlikely that any uniformity in extent of minute crystal contamination of the air would obtain in lockers or rooms that are opened frequently or are chilled by circulated air systems, so that extent and rate of seeding from this source could be highly variable.

Survival of the seed-laden air hypothesis, however, may hinge upon demonstration of the permeability of a 2 mil. film of polyethylene to ultra-fine seed crystals, since we have observed that in straight polyethylene pouches, without benefit of the cellophane laminate, crystal formation proceeds slowly at —10° F. storage even in perfectly sealed and apparently sound envelopes. This behaviour is perhaps analogous to the crystal formation reported by Olsen and Moore *(7)* in the case of waxed paper containers.

Microbiological aspects. The microbiological aspects of the control work and sanitation in the processing of concentrates for lemonade are analogous to those of conventional orange juice processing except that a much sparser microbial population is encountered in the juices than is normal for orange juice. Results of a typical production line check appear in Table 2.

TABLE 2
Results of a bacteriological line check on concentrate for lemonade

Sample	Total Counts	
	Sample	Reconstitute
Juice from Extractors	6,000	—
Juice from Fine Finishers	3,700	—
Conc. Juice from holding Tank	1,400	—
Pulp from holding Tank	17,300	—
Juice-Pulp Mixture	4,100	—
Sugared Batch	980	184
To Filler from Votator	600	113
Frozen Product, from Tunnel	340	64

A breakdown of differential counts during control work for several years indicates that in the juices used, yeasts predominate at about 95% of total counts, with molds accounting for about 4% and bacteria averaging not above 1%. Lindegren yeast agar is used as the standard plating medium in our laboratories, with occasional use of orange serum agar when requested by a co-packer. For the finished product all counts are reported on the reconstitute basis. One ml. portions of a 1:10 dilution of the concentrate are incorporated with 9 ml. of the medium for plating.

Extensive comparisons of results with the two media mentioned show the Lindegren medium to run about 6% higher in total counts due to the fact that it favors yeast growth to about that extent. *Lactobacillus* and *leuconostoc* off-flavors have not been encountered and attempts here and elsewhere at isolation of *E. coli* have thus far yielded negative results.

Total counts on the finished product direct from the freezing unit averaged less than 300 organisms per ml. of reconstitute on 1700 recent production lot samples, with counts ranging from a maximum of 8300 down to zero. During —10° F. storage of the canned product for a period of 30 days initial counts of from 20 organisms to around 8,000 normally drop to values of from 10 to 100. At refrigerated storage temperatures of about 40° F. the attenuation of count is still more marked, as might be expected, and many lot samples are sterile within 30 days.

The hermetically sealed product is not prone to ferment even at normal room temperatures. A reduction in count during 30 days at room temperature is the normal trend and in several instances display samples held for as long as one and two years have shown no signs of fermentative spoilage.

The above comments and data on microbiological aspects must not be taken as indication of little need for strict sanitary control. They do indicate that, *with* good sanitation, excellent results may be achieved.

SUMMARY

The history, nomenclature, and properties of concentrates for lemonade are discussed, with emphasis on the frozen product and on those aspects peculiar to lemons and to lemon juice products. Hemihydrate crystallization, microbiology, equipment for continuous pulp preparation, existing standards, and the preliminary taste discrimination work of the Bureau of Agricultural Economics are touched upon briefly.

Acknowledgment

The invaluable aid of Messrs. B. E. Brink, C. L. Baldwin and R. D. Horner of our laboratories, in collection of data for this report, and of the processors who collaborated in the industry survey, is gratefully acknowledged.

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Notes and Letters

A Rapid and Simple Method to Determine the Maturity and Quality of Lima Beans

It is a well known fact that there is a relationship between stage of maturity, yield, and quality of many vegetable crops. That is, as maturity advances yield increases but quality sometimes decreases. Consideration needs to be given to all three factors in the production of crops used in processing. The consumer desires a product of high quality, whereas the grower is interested in the returns that he is able to get per acre. Consequently, the processor must know what stage of crop may be processed satisfactorily and still give a good return to the grower.

To determine the quality of lima beans many methods are used. There has never been a satisfactory method available for determining prior to harvest the potential quality of lima beans after processing. The determination of the percentage of white or mature beans has been a common method but it is relative and generally of only limited value. The moisture as determined by the Steinlite moisture meter has also proved inadequate. The determination of the alcohol insoluble solids could no doubt be used but this is a method requiring considerable time and thus it has little value for field determinations. There is, then, a definite need for a quick and yet accurate method to determine the quality of fresh lima beans prior to harvest.

The purpose of this paper is to present the results on the microscopic examinations of starch grains at different maturities of two strains of lima beans.

Procedure. The lima beans were grown on a productive sandy loam type of soil at the State Experimental Farm at Farmington, Utah. The 2 strains *873-2-1* and *836-6* were planted on June 3, 1953. The planting of each strain was divided into a number of plots for the purpose of harvesting at 6 stages of maturity. These

plots were randomized within each of 4 replications. To obtain beans of different maturities the following 6 harvest dates were established:

First maturity on August 29.
Second maturity on August 31.
Third maturity on September 2.
Fourth maturity on September 4.
Fifth maturity on September 7.
Sixth maturity on September 10.

Figure 1. Effect of maturity on the structural development of the hylum in the starch grain of lima bean.

After harvest, the pods were shelled and the beans were washed. Immediately following the washing, a slurry of each sample was prepared in 95% alcohol. The microscopic examination was then made on the starch grains from each slurry after the addition of distilled water.

Starch Grain Examination. The slurry was shaken vigorously in an attempt to secure a well mixed sample of starch grains. A drop from each slurry was placed on a slide, a drop of distilled water was added to it, and a cover slip was placed over it. The starch grains were viewed through a microscope to study the structural development of hylum in each starch grain under a 44x objective lens and a 10x ocular. Hundreds of starch grains were examined from each of the samples.

It was observed that the hylum of the starch grain becomes larger and more ramified as the maturity advances (Figure 1). The former confirms the findings of Salunkhe and Pollard *(2)*. Perhaps, this may be due to the varying degrees of dehydration of starch grains. Rahman *(1)* showed the progressive dehydration of beans as maturity advanced. The pattern of microscopic observations of starch grains was identical in both strains of lima beans.

Application. This method is simple enough to be used by fieldmen of the canning companies. They could take random samples of pods from the various parts of the field. After shelling the pods, the beans are ground in a mortar with water and a drop of this diluted slurry is examined under a microscope. When the hylum of most of the starch grains begins to thicken along with its ramifications, then it may be estimated that the field is ready to harvest without much loss of yield or quality.

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Department of Horticulture
Utah State Agricultural College
Logan, Utah.

October 2, 1954.

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Just imagine soup concentrate in a packet that's soluble, odorless, tasteless, nontoxic.

Think of other package uses: Powdered soap or detergents, sugar, puddings and desserts, pharmaceuticals.

—or any product added to water in fixed amounts.

They're all possible with new edible films that are derived from Glycerine or using Glycerine as a plasticizer.

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Annual Meeting Bulletin Board

Columbus, Ohio — June 12-16, 1955

Integrating the technical with the overall Columbus program. From left to right: H. D. Brown, Deatherage, Volle (sitting), and Geo. Garnatz, J. H. Brown (standing).

Columbus program shaping up. The Program Committee is now working on the final layout for the June 12-16 meeting. The initial call for papers and suggestions for discussion groups indicates many new developments of interest to all food technologists. Abstract forms are now being sent to those presenting papers. This is being done to facilitate editorial work and at the same time give each contributor maximum time to complete his finished abstract. *Since these final abstracts are not due until February 1, 1955, there is still time to submit titles and abstracts.* The program committee is anxious to provide the best program ever at any IFT meeting. If you have a paper to present or if there is a problem or topic which should be discussed at the meeting, simply indicate your paper title or discussion topic to:

F. E. Deatherage
Department of Agricultural Biochemistry
The Ohio State University
Columbus 10, Ohio

You will then receive abstract forms to be completed and returned.

In addition to contributed papers a number of symposia on subjects of great importance will make up the program. Already some have been completely arranged and include speakers of outstanding ability and national and international importance.

FEBRUARY 1 LAST DATE FOR APPLICATIONS FOR 1955 FLORASYNTH AWARD

The Florasynth Fellowship Award is given annually to a young man or woman, under 35 years of age, who has outstanding qualities of character and personality and has demonstrated scientific or engineering ability in Food Technology in a recognized college of the U. S. A. or Canada. Candidates must be seniors or graduate students to be eligible for the award. Nomination for the award is made by the head of the department who supervises the work of the candidate.

The 1955 Award nominations (to be made by the head of the department who supervises the work of a candidate) must be received by the Office of the Secretary of the Institute, 176 West Adams St., Chicago, not later than February 1, 1955. After the Awards Committee has come to a decision, the name of the winning candidate will be announced at the annual meeting of the Institute of Food Technologists, June 12-16, in Columbus, Ohio.

Eight copies of each letter of nomination is needed.

CLOSING DATE FOR APPLICATIONS FOR 1955 GENERAL FOODS FUND FELLOWSHIP SET AT FEBRUARY 1, 1955

Funds for this Award are provided by the General Foods Fund, Inc., a foundation supported by General Foods to conduct a graduate fellowship program in the field of food science; the program is administered by the Institute of Food Technologists. The fellowships are granted annually, but will be renewable upon application to and approval by the Awards Committee in order to provide continuity of studies toward the degree of Ph.D. if the winning candidate so plans. Candidates for the Fellowship are selected by the Committee on Awards (IFT) from a roster of applicants who have submitted applications to the Office of the Secretary of the Institute of Food Technologists, 176 West Adams Street, Chicago, prior to February 1, 1955. Applications must be in letter form and furnish the following information: Name; nationality; sex; age; marital status; physician's statement as to health; educational and experience background; college scholarship record; noteworthy research accomplishments; and the applicant's purpose in applying for the Award. Three letters of recommendation shall be forwarded, separately, to the Secretary's Office (IFT) by deans, heads of departments, and/or professors who have supervised the research work of the applicants. A statement by the head of the department where the work will be done, endorsing the applicant and accepting the responsibility connected with the Fellowship, is also required.

To expedite the work of the Awards Committee, candidates are requested to submit eight copies of their applications, letters of recommendation and statements by department heads.

Further details are available in a leaflet which will be supplied on request by the Secretary of the Institute of Food Technologists, 176 West Adams, Chicago, Illinois.

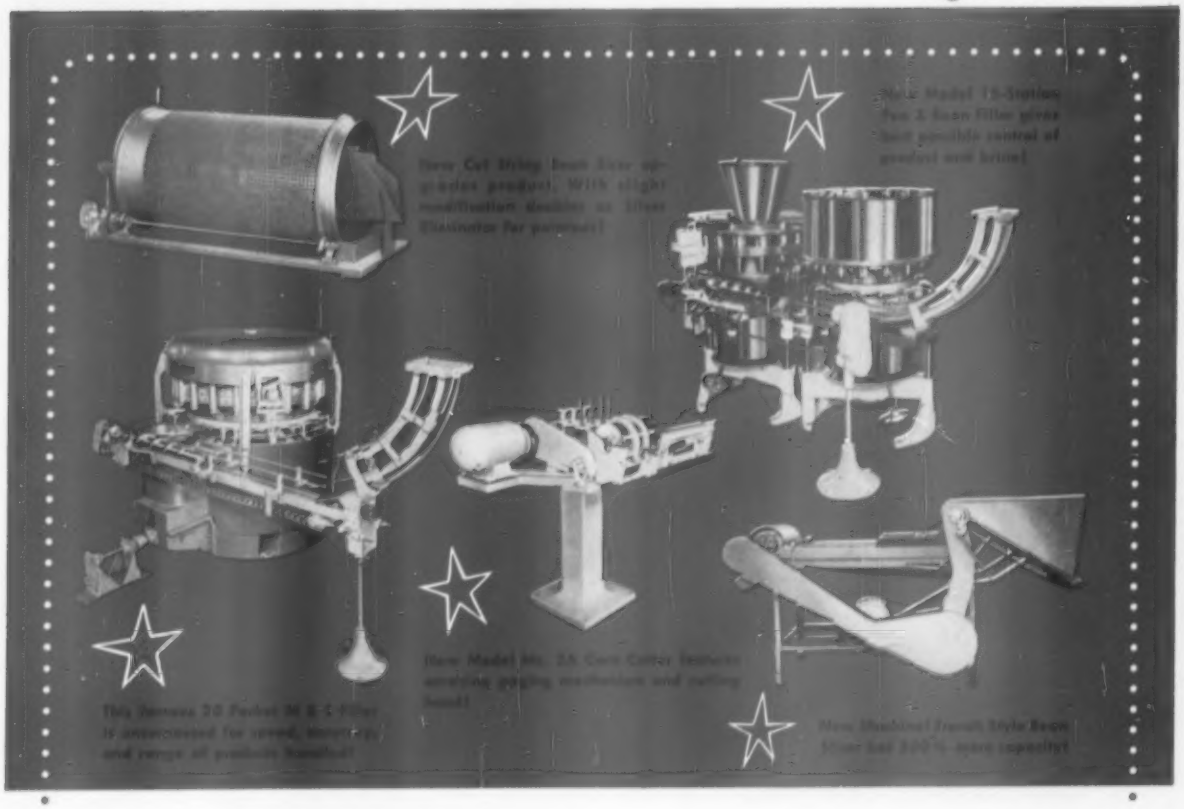
In Memoriam

It is with a feeling of profound sorrow that we announce the passing of James D. Veron, Sales Manager of the Dried Yeasts and Derivatives department, Anheuser-Busch, Inc., on October 31 in St. Louis. Veron, 58 years old, was a native of Bern, Switzerland, where his parents are still living. He joined Anheuser-Busch, Inc., May 1, 1928, and during the early days of his activity with the company served as a technical salesman and demonstrator in the Bakery Products department. Highly regarded and respected, both as an employee and member of the community, Veron is survived by his widow, Madeleine Veron, four children—Diego, Ital, Madeleine, and Esther—and two brothers and a sister who live abroad.

SEE THESE NEW AND IMPROVED MODELS OF fmc FOOD EQUIPMENT

ON SPECIAL DISPLAY AT THE '55 CANNERS SHOW IN CHICAGO
BOOTH NO. 1
FEB. 19-23

EACH A STAR PERFORMER!
EACH DESIGNED TO DO ITS JOB
BETTER THAN EVER BEFORE!



These are but a few of the machines you will see at the FMC booth. Also included will be a display of the FMC "Sterilmatic" cooking principle—the only commercially accepted principle that combines a "continuous operation" with "rolling can agitation" to provide fast, even heat penetration for almost any product and any can size.

See the revolutionary KEY Froth Flotation Cleaner that has set new standards of efficiency for cleaning peas, corn and lima beans; and the continuous Carruthers' Multi-Pak Filler that fills either whole or French-sliced green beans into cans at high speeds. Stop by and visit us at Booth No. 1, National Canners Convention in Chicago, February 19 through 23.

FOOD MACHINERY AND CHEMICAL CORPORATION

Canning Machinery Division

General Sales Offices:

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Diamond Crystal Alberger Salt is

America's largest-selling High-Grade* salt

because...

the exclusive Diamond Crystal Alberger System produces:

Purity—99.95% Sodium Chloride.

Uniformity—maximum purity variation ±0.01% . . . screened to a standard for each food product.

Cleanliness—lowest insolubles of any commercial grade of salt.

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For free consultation on choice and application of the right salt for your food products—call, wire or write:

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Phone—296

. . . in the public interest

Continental Can Company has received a "Certificate of Cooperation" from the U. S. Foreign Operations Administration "for furnishing technical assistance to peoples of friendly countries cooperating to maintain individual liberty, free institutions, and peace." The presentation was made to Mr. C. E. Norton, an IFT member and Continental's manager of Overseas Technical Services, and was signed by Harold E. Stassen, Director of Foreign Operations.

Also from Continental comes word that Dr. L. E. Clifcorn, associate director of Research of the Metal Division Research and Development Department, and IFT president-elect, was elected vice president of the Agricultural Research Institute, an organization which provides financial support for the National Research Council's Agricultural Board and a forum for discussion of the potentialities of research in development of the nation's agricultural resources.

◆ ◆ ◆

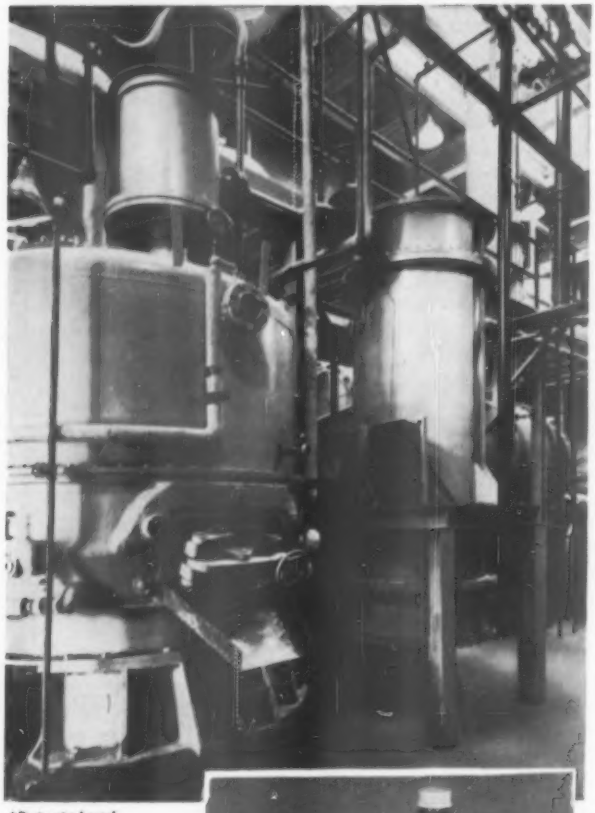
Mr. Ambrose E. Stevens, vice president of Minute Maid Corp., will head the Food Division of the current $411,732 campaign of the George "Junior Republic," according to announcement by Mr. Carl I. Wood, of Thomas Lipton, Inc., general chairman of the drive. In accepting the chairmanship for the fourth successive year, Mr. Stevens stressed the opportunity afforded business leaders to help guide teenagers to useful citizenship through the training and experience they gain at the "Junior Republic." The project began in 1895 with two tents, five citizens, and the faith of Wm. R. George that youngsters can be trained to be responsible adults if given a chance to practice adult responsibilities. It has grown to 600 acres at Freeville, near Ithaca, N. Y., with 27 small cottage homes and shop buildings where 125 boys and girls from 13 to 19 participate in this unique educational experiment.

◆ ◆ ◆

The first fishing trawler to be built as a quick-freeze factory is now in operation by a Scottish firm. It is the 2,600-ton *Fairtry*, believed to be the world's largest trawler. Equipped with the latest machinery for catching, washing, filleting, skinning, and quick-freezing fish, the trawler is also fitted with the latest scientific aids to navigation and to fishing, and with a complete heating and ventilating system so that crew

(Continued on page 30)

Takes the WAVER OUT of spice flavor...



*Patented and Patents Pending

Laboratory Control Assures Predictable Flavor Quality in

SOLUBLIZED SEASONINGS

Now, you can improve the taste of your products with the smooth, mellow blend of **controlled** spice flavors in SOLUBLIZED SEASONINGS. Griffith chemists maintain a new high standard of potency, purity and uniformity in each extractive—by an exclusive extraction process* developed by Griffith research.

With each spice extractive always of uniform quality, blending is a laboratory science that assures flavor control for users of SOLUBLIZED SEASONINGS. That's a big sales advantage worth looking into—**today.**

The **GRIFFITH LABORATORIES, Inc.**

In Canada—The Griffith Laboratories, Ltd.

Another triumph of Griffith research—devoted solely to pioneering better food processing

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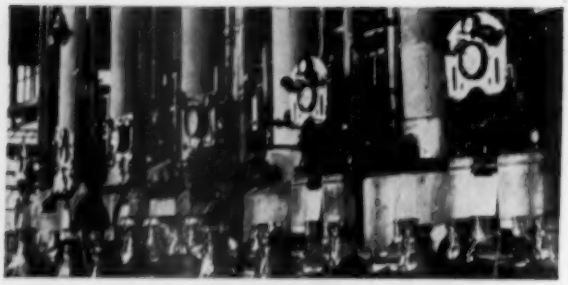

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flavor materials

As a primary source of supply for flavor materials, Givaudan, the world's largest producer of aromatics, has played a dominant role in the development of flavoring science.

We offer you a complete line of flavors for confectionery, ice cream, bakery and other products—all skillfully created to lend true taste appeal. At your request, our flavor staff will study your individual problem and make recommendations from hundreds of proven Givaudan flavors. Or we will develop an individual creation to meet your specific needs. Make Givaudan your flavor headquarters.

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Branches: Philadelphia • Boston • Cincinnati • Detroit
Chicago • Seattle • Los Angeles • Toronto

FOOD INDUSTRY TOPICS

(Continued from page 28)

and factory workers can live comfortably. Of interest is her unique method of catching fish — trawling is done over the stern, and the catch is taken up through a ramp to the fish pounds.

◆ ◆ ◆

"Buy It in Glass Week," held in Millville, N. J., Oct. 25-30, proved so successful that it is likely the event will become an annual affair and be celebrated nationally. Key to the success of the promotion was the close cooperation of local unions of the sponsoring Glass Bottle Blowers Assn. (AFL), Millville glass industries, and the community. Millville, site of one of the Armstrong Cork Co.'s glass plants and the T. C. Wheaton glass plant, is one of the nation's leading glass production centers.

◆ ◆ ◆

Canned soft drinks could eventually account for an increase of 30% in the nation's use of metal cans—already 35.6 billion a year—according to Mr. E. K. Walsh, assistant general manager of sales for American Can Co. "If cans for soft drinks follow a trend going on in this country for the past two decades," Mr. Walsh said, "canned carbonated beverages may ultimately reach the 12-billion-a-year mark." The sales executive pointed to the history of beer-in-cans as a possible gauge of the future of canned soft drinks, for which 1954 was a "year of development." Annual production of beer cans now runs to over six billion, he said, and that takes to market about 33% of all packaged beer.

◆ ◆ ◆

The successful commercial operation of a dairy waste disposal process developed by the USDA and Pennsylvania State University was reported recently. The process, developed by Drs. Sam R. Hoover and Nandor Porges of the USDA, and Rupert R. Kountz, of the University, has been installed by two New Jersey dairies and six more installations are under construction in Pennsylvania and New Jersey, it was reported. In the process, the milk waste, which comes mostly from washing the containers and equipment, undergoes an aerobic oxidation by micro-organisms. The effluent from the system can be discharged to streams without danger of pollution.

. . . *things new under the sun*

To reduce problems of close-up color photography to an absolute minimum, the Eastman Kodak Company announces a **new technical close-up attachment** particularly suited to photographic problems in industrial and scientific laboratories. The Technical Close-Up device is built around a simple, sturdy frame to which camera and flashholder are attached. Two arms extend from this plate, out in front of the camera, to support a half-frame. The attachment is offered in two basic kits. One, for use with the Kodak Pony 828 or 135 camera, and known as the Kodak Pony Close-Up Kit, is priced at $19.95. The Kodak Technical Close-Up Outfit, priced at $62.75, includes the Kodak 828 Pony Camera, the close-up attachment, and other accessories. Address Eastman Kodak Co., Rochester 4, N. Y.

(Continued on page 32)

Announcing

A COMPLETE CULTURE MEDIUM

Specifically designed for the luxuriant growth of all Lactic Acid Bacteria, Yeasts and Molds.

EXCHANGE BRAND
ORANGE SERUM AGAR #77
(DEHYDRATED)

Orange Serum Agar #77 assures an adequate supply of vitamins, amino acids and other organic compounds valuable for the stimulation of the rate of growth of microorganisms.

Laboratory Proved
Standardized
Fortified—
as a complete medium by fortification with yeast and meat hydrolysates, cysteine, etc.
Protected—
a special feature—contains an in-package desiccant.
Potential Use—
as an all-purpose medium for a variety of bacteria, yeasts and fungi.

Available through your laboratory supply house in 1-pound bottles.

Exchange

PHARMACEUTICAL CITRUS PRODUCTS

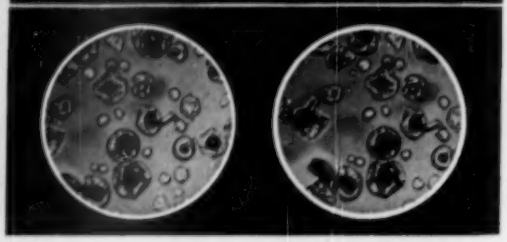
Sunkist Growers

PRODUCTS DEPARTMENT
ONTARIO, CALIFORNIA

P&S

POLVAROMAS

the PERFECT ANSWER to POWDERED FLAVORS



As illustrated in the above photomicrographs, Polvaromas are made through a special P & S process whereby a drop of flavor is entirely surrounded by a protective coating of edible, non-toxic vegetable material. With Polvaromas the flavor is not dried on the surface of a powder, but is locked within. This is proof of your gaining optimum flavor stability.

Here at last is the perfect flavor solution for all food products which are based on a dry composition.

Polvaromas are available in all popular flavors. We shall be happy to submit samples and further technical information for your approval.

USES FOR POLVAROMAS

SOFT DRINK POWDERS · GELATIN DESSERT POWDERS
PUDDING POWDERS . . . . . PIE FILLER MIXES
ICE CREAM MIXES . . . . . ICE & SHERBET MIXES
DAIRY MILK DRINK POWDERS . . . . CHEWING GUM
CAKE & COOKIE MIXES . . . . . ICING MIXES

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CHICAGO • DETROIT • LOS ANGELES • MILWAUKEE • TORONTO

FOOD INDUSTRY TOPICS

(Continued from page 30)

The Lunkenheimer Company is announcing the **first all molded PVC valves and fittings.** This line, designed and engineered by Lunkenheimer, has been patented and registered under the name "Luncor," which refers to its remarkable resistance to corrosive chemical action. The new polyvinyl chloride valve resists most chemicals used in industry, and is exceptionally strong. The valve is molded in rigid form, suitable for pressures up to 125 pounds and 150° F. temperature. It is presently available in a Y-type globe design. Market price will be below stainless steel and other alloy valves. Details can be obtained from The Lunkenheimer Co., Cincinnati 14, O.

◆ ◆ ◆

The first portable electric color sorting unit ever manufactured has been completed by the Electric Sorting Machine Co., 410 44th St. S. W., Grand Rapids, Mich. Designed for the fully automatic sorting of seed peas and beans, the unit consists of 12 photo-electric sorting machines permanently mounted in a 35-foot trailer, complete with power supplies and other auxiliary equipment. The Grand Rapids firm pioneered application of the photo-tube "electric eye" to problems of color sorting. The specially designed trailer in which the sorting machines are housed was manufactured by the Trailmobile Co., Cincinnati, O.

◆ ◆ ◆

A new, heavy-duty, high-capacity moisture, dirt, and oil separator for compressed air lines and equipment is announced by Beach Precision Parts Co., 120 Mechanic St., Boonton, N. J. The new model, No. 125 S, has been added to the Beach line of compressed air separator equipment to provide a 125 c.f.m. (at 100 pound pressure) unit that will sell at less than $100. Other models are designed to handle 30, 65, and (Model 300 S) up to 300 c.f.m. The 125 S is for ½" connections. Equipped with four Beach Sta-Dri cellular filters, Model 125 S is designed to handle two million or more cubic feet of compressed air without change of filter elements.

◆ ◆ ◆

Now—you can learn to express your ideas clearly and naturally merely by listening to five self-teaching records for a few minutes a day right in your own home. The course includes five double-side 10" non-breakable records (78 r.p.m.) in a beautifully bound, sturdy album, plus printed instructions so that you can follow radio announcer Milton Cross' words with your eyes while you listen. Soon you learn to speak fluent effortless, effective English the easy way . . . by listening and imitating. The Effective Speaking Course can be ordered from American Homecraft Co., Dept. F, 3714 Milwaukee Ave., Chicago 41, Ill. It sells for $8.95 postpaid, and satisfaction is guaranteed.

(Continued on page 34)

RECOMMENDATIONS FOR USING

MERORY FULL AROMATIC TRUE FRUIT FLAVOR

(PATENT PENDING)

10 Fold BLACK RASPBERRY, MF.954

(FLAVOR MEASUREMENTS PUBLISHED IN THE NOVEMBER, 1954 ISSUE OF FOOD TECHNOLOGY)

IN FRUIT FLAVORS, LIQUID FRUIT, DAIRY PRODUCTS, GELATINE DESSERT, CONFECTIONERY, ICE CREAM, SHERBET, FRUIT ICE, AND BAKERY PRODUCTS

FORMULA #1—TRUE FRUIT FLAVOR

Mixture of

30 Gals. 10 Fold BLACK RASPBERRY MF.954
58 Gals. Water
or: Red Raspberry Juice
12 Gals. Alcohol 95%

100 Gals. Flavor with natural raspberry color

Use 6 to 8 fl. ozs. per 1 gallon of syrup
(Incl. 1¼ fl. ozs. Acid Citric 50%)

FORMULA #2—FRUIT FLAVOR WONF

Mixture of

15.5 Gals. 10 Fold BLACK RASPBERRY MF.954
84.5 Gals. Nulomoline—42 Baumè
or: Alcohol 15%
and: additives of Orris Concrete
Oils of Jasmin, Cassie, and Rose
in alcoholic solution.

100 Gals. Flavor—addition of color required

Use 4 to 6 fl. ozs. per 1 gallon of syrup
(Incl. 1¼ ozs. Acid Citric 50%)

FORMULA #3
MERORY FULL AROMATIC—LIQUID FRUIT

Mixture of

1 part of 10 Fold BLACK RASPBERRY MF.954
9 to 14 parts of Sugar Syrup 40-42 Baumè—pure cane, partially inverted

10 to 15 parts LIQUID BLACK RASPBERRIES—FULL AROMATIC FRUIT SYRUP
(no preservatives required)

FORMULA #4—LIQUID BLACK RASPBERRIES in DAIRY PRODUCTS

Mixture of

10 parts LIQUID BLACK RASPBERRIES (formula #3)
90 parts MILK, or YOGURT, or BUTTERMILK, or SOUR CREAM, or CHEESE

(Liquid fruit will stay solidly on bottom of dairy container if so desired)

FORMULA #5—FULL AROMATIC RASPBERRY GELATINE DESSERT

Add

One envelope (8 grams) of unflavored gelatine dissolved in
¼ cup of cold water, stir and mix with
1¼ cup of boiling water, and to it add
¼ teaspoon of salt,
3 teaspoons of lemon juice,
½ cup or 4 fl. ozs. LIQUID BLACK RASPBERRIES
(formula #3)

FORMULA #6—FULL AROMATIC BLACK RASPBERRY GELATINE DESSERT and PUDDING FLAVOR

Mixture of

80 fl. ozs. 10 Fold Black Raspberry MF.954
16 fl. ozs. Stable Black Raspberry Imitation MF.411
(Made by MERORY FLAVORS INC.)
32 fl. ozs. Alcohol 95%

128 fl. ozs. Flavor

Use 0.1 ml. per 3 ozs. of unflavored
gelatine dessert mixture.

FORMULA #7—BAKERY GOODS

Mixture of

10 pounds of LIQUID BLACK RASPBERRIES
(formula #3)

with

90 pounds of ICING, TOPPING, or MARSHMALLOW

FORMULA #8—CONFECTIONERY—FULL AROMATIC CREAM CENTER

Mixture of

10 pounds 10 Fold BLACK RASPBERRY MF.954
90 pounds of CREAM CENTER
(or to 140 pounds of Cream Center)

(no fruit additives required)

FORMULA #9—ICE CREAM and SHERBET

Use

1 to 2 Gals. LIQUID BLACK RASPBERRIES
(formula #3)

or

12 to 24 fl. ozs. of 10 Fold Black Raspberry MF.954

per

10 Gals. ICE CREAM MIX or 20 Gals. SHERBET
(No fruit additives required)

FORMULA #10—FULL AROMATIC ICE POP and FRUIT ICE FLAVOR
(Natural Raspberry Color)

Mixture of

64 fl. ozs. of 10 Fold Black Raspberry MF.954
2 fl. ozs. of Stable Raspberry Imitation MF.414
(Made by MERORY FLAVORS INC.)
14 fl. ozs. of Propylene Glycol
Water or Red Raspberry Juice QS. to make:
128 fl. ozs. FULL AROMATIC RASPBERRY
ICE POP or FRUIT ICE FLAVOR
(No emulsifying agent required)

Use 1 fl. oz. per 5 Gals. Ice Pop or Fruit Ice Mix.

MERORY FLAVORS, INC., 697 ROUTE 46, CLIFTON, NEW JERSEY

FOOD INDUSTRY TOPICS

(Continued from page 32)

Fast, simple projection of true-color microscope specimens for group study is made possible by a **new micro-projector** announced by Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y. The Speed-Matic Micro-Projector operates as simply as an ordinary slide projector without annoying distractions caused by lens changing, condenser focusing, or arc lamp adjustments according to its designers. The instrument, fully described in Catalog E-246, is priced at $1,195, complete with four-lens optical system. The basic illuminating system and reflecting prism alone can be purchased for $376 for use with existing microscopes which have substage condensers.

◆ ◆ ◆

Ordinary drinking water can now be demineralized instantly to meet the newest specification of the U. S. Pharmacopeia, and a new term reportedly has been added to the drug field—"Purified Water." To meet increasing demands for "purified water," a low-cost, economical method is being provided through an improved unit manufactured by Crystal Research Laboratories, Inc., 29 Allyn St., Hartford 3, Conn., and known as "Crystalab Deeminizer CL-5." The unit transforms good drinking water into U. S. P. "purified water" at a rate as high as five gallons per hour, continuously; or a reservoir at the bottom controls flow so that an ounce or several quarts of "purified water" can be drawn off instantly when needed. Deeminizer also comes equipped with direct-reading Quality-Check Meter having dial graduated 0 to 50 in p.p.m. as NaCl, which stands guard to control effluent quality at all times. The complete unit requires only 6 x 8" of bench space. No plumbing connections are needed.

◆ ◆ ◆

The Model 515 "Alphatron" Vacuum Gauge, utilizing a sealed radium source, indicates pressures from one micron (0.001 millimeter) to 10 millimeters of mercury. Pressure is read from a single four-decade logarithmic scale; no switching from one range to another is necessary. The gauge is small, rugged, and portable, requiring only a source of 110-volt 60-cycle alternating current. The instrument, priced at $225, is described in a catalog sheet available from Naresco Equipment Corp., Equipment Sales Subsidiary, Nat'l. Research Corp., 160 Charlemont St., Newton Highlands 61, Mass.

◆ ◆ ◆

C. G. Sargent's Sons Corp., Graniteville, Mass., announces a **new, portable, completely self-contained dryer** available on a rental, rental-purchase, or outright purchase basis. It is believed to be the first such machine to incorporate every known feature of a research laboratory dryer with the tremendous advantage of portability. The dryer is full-size, fully

(Continued on page 36)

AO LABORATORY MICROSCOPES

Feature after feature for superior performance, easier manipulation, permanent satisfaction:

CUSTOM TENSION — Substage and coarse adjustments may be set to your touch.

"PINCH GRIP" STAGE — Permits slides to be interchanged without disturbing stage settings.

"AUTOFOCUS" STOP — Facilitates study of slides of similar thickness in rapid succession, reduces slide breakage, prevents racking objectives into condenser.

ALL CONTROLS AT FINGERTIPS — Fine adjustment closer to stage and substage controls. Dual knobs separated for finger clearance.

MICROMSTER-SCREW FINE ADJUSTMENT — "Spring-loaded" to eliminate back-lash. Smooth, long-wearing ball-bearing slideways.

AMERICOTE OPTICS — (Optional), Reduce internal reflections and improve image contrast.

BUILT-IN ILLUMINATION — Eliminates adjustment. Uniformly fills the field at all powers.

CHOOSE AO INSTRUMENTS to simplify your job of guarding food quality

DIRECT RESULT COLORIMETER

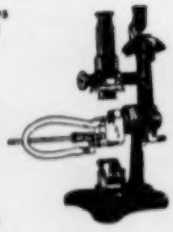
For tests where color density indicates composition quantitatively.

P45 POLARIZING MICROSCOPE

A capable polarizing instrument with the same time-saving features as the No. 78 Microscope.

TIME-SAVING NO. 78 MICROSCOPE

The simplified microscope for speedier focusing and manipulation provides more comfortable working position. The ideal routine instrument.



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To determine total dissolved solids by measuring refractive index.

AO SPENCER STEREOSCOPIC MICROSCOPES

Thoroughly proven. Thousands used in industrial laboratories everywhere. They simplify identification and counting of adulterants, etc.

DARKFIELD QUEBEC COLONY COUNTER

For estimating the bacterial concentration in dairy products.

For YOUR laboratory, be sure to specify AO Spencer Microscopes, Illuminators, Colony Counters, and other Scientific Instruments. We will gladly supply literature or assistance on inspection problems. Write Dept. M190

American Optical
INSTRUMENT DIVISION
BUFFALO 15, NEW YORK

Foods move faster from counter to table

when MSG* is on the label

Payoff on processed food sales comes when shoppers reach for one brand instead of another. Make sure it's yours by using Huron MSG.

Frozen foods — chicken pies, fish, meat, poultry, and vegetables — retain their pre-freezing flavor longer when you use Huron MSG. In many cases it also helps preserve their original color.

Canned foods — soups, gravies, hash, beans and others — keep their original flavor through all three cookings (yours plus the housewife's) with Huron MSG (made *only* from wheat protein).

Small fry make a big difference in selling food.

In the shoppers' home, your product has nothing more or less than its own flavor to stand or fall on. If it passes this critical taste test, it rates a permanent place on the family shopping list.

That's why so many processors "insure" taste appeal with Huron MSG — America's first MSG and still the quality standard. You can be next!

For suggestions and sample, write Huron's Technical Service Department, HURON MILLING CO., 9 Park Place, New York 7, N.Y.

* Huron MSG, of course!

8.4.2

Huron MSG

PURE MONOSODIUM GLUTAMATE 99+%

Made by the American pioneers in protein derivatives

SALES OFFICES: 161 E. Grand Avenue, Chicago 11 • 13 E. Eighth Street, Cincinnati 2 • 383 Brannan Street, San Francisco 7

FACTORIES: Harbor Beach, Michigan

the greatest advance in meat seasoning

Scientifically manufactured MAGNA SPICE CONCENTROLS have modernized the seasoning of meats by making available the true flavor components of herbs and spices in the most concentrated form known to Science . . . yet easily processed in your own plant. All the flavor is released immediately. Each batch of your product is uniformly and identically seasoned.

- **Out perform crude herbs and spices.**
- **Easy to measure — easy to mix.**
- **No spoilage.**
- **Cut seasoning costs up to 40%.**

Write for the new MM&R booklet — "The Greatest Advance in Meat Seasoning."

MAGNUS, MABEE & REYNARD, INC.

Since 1895 • One of the World's Greatest Suppliers of Essential Oils and Flavors

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221 NORTH LaSALLE STREET, CHICAGO 1, ILL., U.S.A.

FOOD INDUSTRY TOPICS

(Continued from page 34)

instrumented, and uses either steam-heated or electrically-heated air. Designed primarily as a research laboratory dryer for pilot plants, and for industrial and school laboratories, it is equipped for tray drying, or for pole, roll, or plate drying, as desired. It may be operated manually or automatically, or in combination, and each variable, including air velocity, in the drying process may be changed at will without disturbing any other factor.

◆ ◆ ◆

The new "Sani-Flex" sanitary pump, latest in a line of corrosion and contamination resistant pumps, is shown and described in a bulletin offered by the Vanton Pump & Equipment Corp., Empire State Bldg., New York 1, N. Y. The unit, designed in accordance with Health Dept. and food processor recommendations, has no stuffing boxes, shaft seals, check valves, or gaskets. Fluid is isolated from all moving parts. It is recommended for use in the dairy, food, pharmaceutical, bottling, chemical, and industrial fields for handling viscous materials or abrasive slurries as well as for pumping food products, pharmaceuticals, and chemically pure fluids.

◆ ◆ ◆

Development of a **new type of thermocouple** of very rugged construction which features extremely fast response, used for measuring very rapid temperature changes of metal wall surfaces, has been announced by the Engineering Division of Midwest Research Institute, 4049 Pennsylvania, Kansas City, Mo. The instrument, applicable for recording temperatures in such equipment as cylinder and piston walls, brake drums, autoclave walls, and air ducts, has been specifically designed to operate effectively under adverse conditions, and has been satisfactorily tested at pressures up to 60,000 psi under severe mechanical vibration. Two models—a small one for use in thin walls, and a large one for use in thick walls—will be made available on essentially an at-cost basis. For further details write Mr. F. N. Stephens at the above address.

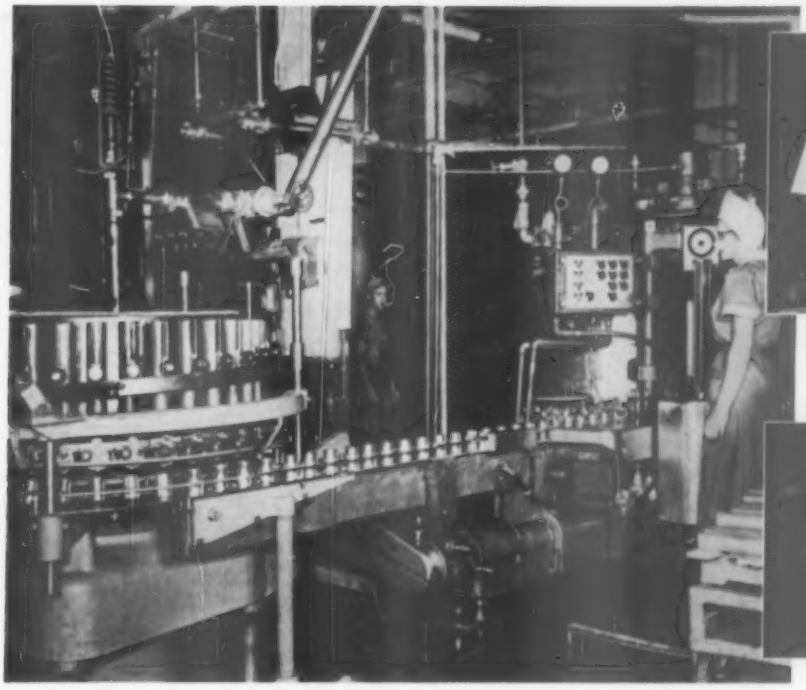
◆ ◆ ◆

Automation—automatic control—moved ahead another notch with the first public showing recently of a new Norelco Autrometer, displayed by the Research & Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. The Autrometer checks constituents in specimens by comparing them with standards. Percentages of as many as 12 elements can be determined with an accuracy equivalent to chemical methods but at a speed many times faster. The new Norelco development is expected to be of great help to the process industries in production and quality control applications. It will also be used to control incoming raw materials thus freeing the chemist for more important work.

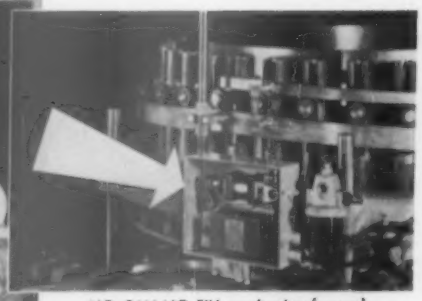
◆ ◆ ◆

Designed to coordinate with a standardization program relating to use of ASTM-type distillation for the characterization of lubricating oils and reduced crudes, the new Glenlab-made vacuum-jacketed distilling column provides for standardized operations to

(Continued on page 38)



FASTEST filling machine yet built, first Pfaudler 35 was installed in this Heinz baby food line.



NO-CAN-NO-FILL mechanism (arrow) is electrically controlled, pneumatically activated. Handle at top of machine is used to adjust amount of fill; accurate to ±1/10 oz.

ELECTRIC BRAKE on underside of filler permits split-second stopping.

Another milestone in food packing . . .

New 800-can-a-minute filling machine makes its debut at Heinz Canadian Plant

800 cans of baby food a minute!

That's the story at the H. J. Heinz Co. plant, Leamington, Ontario, Canada, where the first Pfaudler 35 station piston filler earned its wings.

If you package viscous or semi-solid products, you'll be pleased to know that *you* can now enjoy the same high-speed, 800-can-per-minute filling.

To make this speed possible, we've given the new Pfaudler 35 several unique design features—an electric brake that stops the machine within 2/10 of a second; a pneumatic no-can-no-fill mechanism which is electrically controlled; an adjustable track which tilts the speeding cans to the proper angle for filling.

Easy maintenance

You have only three points on the entire machine to lubricate by hand. All gears are immersed in oil and automatic forced lubrication is supplied to all bearings in the base.

One man can clean the machine. There are only two parts for him to remove—the valves and the pistons—and no tools are needed. Liquid seal eliminates piston rings.

This machine accurately fills cans, jars and composition containers up to 16 oz. You can adjust amount of fill precisely, to within ±1/10 oz. in most cases.

Bring high-speed filling into your plant, with the fastest filler in the world. *Mail the coupon today.*

THE PFAUDLER CO.
Dept. FT-1, Rochester 3, N. Y.

Please send full data on the new Pfaudler 35 station piston filler.

Name_____

Company_____

Title_____

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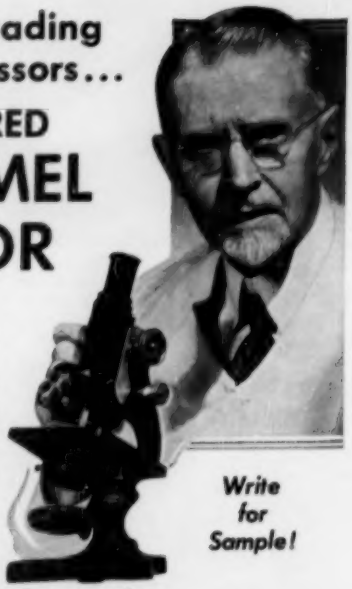
THE PFAUDLER CO., ROCHESTER 3, N.Y.

Used by Leading Food Processors...

POWDERED CARAMEL COLOR



A dehydrated food color, made entirely from dextrose sugar by cooking under controlled conditions.

It has particular use in dry food products where the use calls for a natural color ranging from a light to a very dark brown. For example:

Write for Sample!

Powdered Desserts *Dehydrated Soups*
Dry Cake Mixes *Bouillon Powders*
Powdered Coffee & other beverages
Powdered Gravy Seasonings

S. TWITCHELL CO.
CRESTMONT & HADDON AVES • CAMDEN 4, N.J.

FOOD INDUSTRY TOPICS

(Continued from page 36)

be conducted under vacuum. Test operations have been conducted for over a year with a wide variety of stocks, at temperatures up to 750° F. and pressures down to 1 mm Hg. No breakage has been encountered and the experience shows that distillation and warm-up time are not critical. Write Mr. Frank Haylock, Glass Engineering Laboratories, 536 O'Neill Ave., Belmont, Calif., for further detail.

Humpty Dumpties French Toast is currently making its appearance in frozen food cabinets throughout the U. S. for the first time. Packaged in a four-color waxed overwrap by Western Waxed Paper Div., Crown Zellerbach Corp., each carton contains four slices of toast. The reverse side of the overwrap features tempting recipes. The new product is marketed by the French Toast Corp. of America, Red Hook, N. Y.

Major advances in the low-cost, non-woven fabric field were announced recently by the Leshner Corp., Hamilton, O. The firm has been working for 10 years in development of lightweight, disposable, non-woven products. First innovation to be marketed is a non-woven cheesecloth wiper, called "Wip-Eez." Perfected after five years of research, the re-usable Leshner product is lintless, triple-absorbent, all cotton, and priced far below the conventional non-disposable cloth rags now in use. "Wip-Eez" will be packaged in re-usable moisture-proof containers, five cloths in each, at a suggested retail price of 39c and 20 cloths at a suggested retail price of $1.29, and in 100-foot rolls in convenient dispensing containers. Each package will contain 10,200 sq. in. and sell at a suggested retail price of 49c.

The increasing number of high pressure boiler installations have brought about a tremendous need for minimizing corrosion of boiler tubes and auxiliary equipment. Now Arnold O. Beckman, Inc., 1020 Mission St., So. Pasadena, Calif., announces Model 2B2B Dissolved Oxygen Analyzer to meet the requirements of the modern power plant for continuous measurement of dissolved oxygen in boiler feedwater. The unit consists of a sample flow regulating an ion exchange unit, an analysis unit, and a modified recorder.

Two new pressure sensitive Cotton Cloth Tapes are available from the Permacel Tape Corp., New Brunswick, N. J. The self-sticking printable tapes are designed to meet requirements of JAN-P-127, Tape II, Grade B, and are adaptable for bundling parts, wires, cables, tubing, and other materials used for storage, marketing, or inter-plant purposes. Sizing prevents lint contamination of the adhesive, prevents increase of adhesion to backing in tightly wound rolls, and facilitates easy dispensing and cross tear. Marketed under the names of Permacel 641 Production Grade Sized Cotton Cloth Tape and Permacel 651 Medium Strength Sized Cotton Cloth Tape, they can be employed in holding cold rivets prior to being set, holding insulation on pipe lines, and holding loose or movable parts on machines and equipment during shipment.

Designed primarily for fine filtration or clarifying purposes, the ClaRite filter operates on a simple 3-step principle of precoating, filtering, and backwash cleaning. This last feature eliminates manual cleaning and disassembly for replacement of internal parts. The filter is applicable to processing acids, alcohols, beverages, drugs and cosmetics, solvents, food products, and water. Write for four-page brochure to Croll-Reynolds Engineering Co., 17 John St., New York 38, N. Y.

International Staple and Machine Co., 809 E. Herrin St., Herrin, Ill., announces a **newly designed air-operated portable stapler.** The new Model AB-1 replaces International's former pneumatic stapler, Model HPA. The stapler weighs only 8 pounds, 12 ounces, as opposed to the 24 pounds of its predecessor. This reduction was made possible by use of a new, two-cycle air motor and other steps which simplified

(Continued on page 40)

24 CHOCOLATE CANDY BARS
CANDY BAR
Memo from A. S. Last
Food Technol
Tell Jim we could improve quality and flavor if we used Morton '999' Salt

Candy makers need Morton '999' Salt to prevent quality variations. So do makers and processors of beer . . . canned foods . . . cereals . . . seasonings . . . pasta products . . . malted milk . . . mayonnaise . . . meats . . . margarine . . . olives . . . sauerkraut.

MORTON '999' SALT **insures uniform quality** in processed foods for two reasons. It's guaranteed to contain more than 99.9% pure sodium chloride—*always!* The 0.1% (or less) is a neutral inert sodium salt—never bitter calcium or magnesium compounds.

Vacuum pan evaporation assures that this salt will be clean . . . free-flowing . . . evenly soluble. It has a constant weight per volume ratio . . . won't pack down.

MAIL COUPON FOR FURTHER DETAILS TODAY!

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THE SALT THAT CARRIES ITS OWN GUARANTEE

MORTON SALT COMPANY
Industrial Division, Dept. FT-1
120 So. La Salle St.
Chicago 3, Illinois

I should like to receive . . . without obligation . . . more information on Morton '999' Salt and methods of using it in my product.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

FOOD INDUSTRY TOPICS

(Continued from page 38)

the complex mechanisms formerly necessary in a stapler of this type. Price is less than half that of the former International pneumatic stapler.

. . . *the literary corner*

American science and technology, more than any other factor, provide the principal deterrent to the forces of aggressor nations, according to the November issue of *Industrial Research Newsletter,* published by Armour Research Foundation of Illinois Institute of Technology, Technology Center, Chicago 16, Ill. To help maintain our supremacy, the *Newsletter* continues, the Federal government in the current fiscal year will spend $1,700,000,000 on research related to the nation's security. This is 85% of all government spending for scientific research and development. New product and process information or word of new ideas should be sent to Mr. Frank Judd, editor.

Issue No. 5 of *The Givaudan Flavorist* for 1954 contains a well-referenced article on nuts and their role in flavoring, and an easily digested shorter article on blenders. Givaudan's address is 330 W. 42nd St., New York 36, N. Y.

Coleman Instruments, Inc., 318 Madison St., Maywood 1, Ill., submits a well-detailed 62-page catalog on its "tools for science," including pH electrometers, spectrophotometers, nephelometers, colorimeters, titrators, and photo-fluorometers. Among the "firsts" the firm has scored are included the first commercial glass electrode pH electrometer, the first "Universal" spectrophotometer, the first rational system of nephelometry, and the first permanently stable tablets for producing buffer solutions of precise pH.

A new technical bulletin describing use of citric acid and its esters as sequestering agents in edible fats and oils has been issued by the Chemical Sales Division of Chas. Pfizer & Co., Inc. The bulletin, No. 72, outlines the steps for sequestering metallic ions during hydrogenation and deodorization processes. Address is 630 Flushing Ave., Brooklyn 6, N. Y.

Fatty Acid News Digest, published by Fatty Acid Division, Assn. of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y., carries a reminder that information on publication and availability of papers presented at the Fall Meeting of the American Oil Chemists' Society is available at the Society's headquarters, 35 E. Wacker Dr., Chicago.

The Seaplant Chemical Corp. has recently published Vol. I, No. 2 of the new house organ, *SeaKem EXTRACTS.* In addition to stories on the use of Sea-Kem Irish Moss extractives in solving a variety of stabilizing problems, this issue reports a new discovery in the structure of carrageenin as revealed at the national meeting of the ACS. Also included is a list of papers on Natural Plant Hydrocolloids now available in booklet form in the ACS "Advances in Chemistry" series. To receive *SeaKem EXTRACTS* regularly, write Mr. Byron Spence, Seaplant Chemical Corp., 63 David St., New Bedford, Mass.

"Neither snow, nor sleet, nor any other kind of condition can hurt our product." For manufacturers who want to know just how good their merchandise is or how well it stands up under impact, heat, light, vibration, or a host of other tests, the modern research and testing laboratory stands ready to answer these questions impartially. Foster D. Snell, Inc., illustrates this in their newest 8-page booklet entitled *Product Evaluation and Physical Testing,* listing the company's specialized services in developing, improving, and evaluating products. Write Public Relations Dept., Foster D. Snell, Inc., 29 W. 15th St., New York 11, N. Y.

In a new 4-page list of compounds available, BIO-RAD Laboratories, 800 Delaware St., Berkeley, Calif., includes a helpful alphabetical index of compounds, including alternate nomenclature, and providing index numbers to location in the chemical classification list. The compounds listed include simple carbon compounds, alcohols and derivatives, acids and derivatives, amino acids, purines and pyrimidines, miscellaneous compounds, and nitrogen-15 labeled compounds.

. . . *building up and branching out*

Gehrke Brokerage Co., 904 Builders Exch., Minneapolis 2, has been appointed broker in a wide area of Minnesota for Huron Milling Co., 9 Park Pl., New York City 7, it was announced by Mr. Glenn Freeman, director of sales, Specialty Products. The Gehrke Company will handle Huron's two flavor-boosters—MSG (monosodium glutamate) and HVP (hydrolyzed vegetable protein). Under the Huron-Gehrke agreement, the latter will service food manufacturers and processors.

To serve the rapidly growing industrial south, Rietz Mfg. Co., Santa Rosa, Calif., has opened offices in the Forsyth Bldg., Atlanta, Ga. Sales and service on Rietz disintegrators, prebreakers, and thermascrews will be provided by this headquarters. Under the direct supervision of IFT member Arch B. Dunwody, a Rietz vice president, the Atlanta office will serve Georgia, Kentucky, Tennessee, Mississippi, Alabama, Florida, No. Carolina, and So. Carolina.

A new instrument service and assembly building in San Leandro, Calif., was officially opened November 1 by The Foxboro Company of Foxboro, Mass., manufacturer of industrial instrumentation. Keeping pace with industry's increased demand for instruments, the new factory has more than doubled the company's West Coast manufacturing facilities, providing 8400 sq. ft. of space for the service, production, and sales departments. The building is centrally located at 399 Preda St., close to the Oakland Municipal Airport and the Eastshore Freeway.

. . . *meeting hall and conference room*

The Honorable Robert T. Stevens, Secretary of the Army, will be guest speaker at the Annual Winter Banquet of the Quartermaster Association, Chicago Chapter, January 14, at the Palmer House. Mr. Stevens has always had a keen interest in research and development on food, a huge item in Army supply. Reservations may be made with Col. G. F. McAneny, 1849 West Pershing Road, Chicago 9, Illinois.

"A World of Flavor" was the theme of the first Dodge & Olcott exhibit at the annual meeting of the American Meat Institute, held in the Palmer House, Chicago, in October. Featuring the company's new line of dry soluble seasonings sold under the trade name SPISORAMA, the 24-foot exhibit was designed and built by D&O personnel. Also during this convention initial announcement of the establishment of the annual D&O Award for outstanding achievement promoting the growth and general welfare of the meat packing industry was made. The award will consist of $1,000 and a gold medal. Second from right (foreground) in the exhibit picture above is Mr. John L. Cassullo, D&O president.

The fact that research can and does help industry produce better and cheaper products was demonstrated at an October luncheon at Chicago's Palmer House by Arthur D. Little, Inc., industrial research, consulting, and engineering firm of Chicago and Cambridge, Mass. D. Reid Weedon, Jr., vice president, told of the silk purse which the company's founder, Dr. Arthur D. Little, actually made out of a sow's ear to prove that the seemingly impossible can be done if attacked with insight and understanding, and that problems can be solved with patience and the knowledge of sound scientific principles.

. . . *the human element*

American Cyanamid Company, 30 Rockefeller Plaza, New York City, announces appointment of **Mr. Burton F. Bowman** as general sales manager of the Fine Chemicals Division. Mr. Bowman will direct operations of the Division's pharmaceutical, animal feed, and food industry sales departments, and activities of the advertising and market research departments. Prior to joining the Fine Chemicals Division, he was vice-president in charge of sales for two years at the Huron Milling Co. His other experience in the sales managerial field was at Pillsbury Mills, with which he was associated for 18 years in various positions relating to the firm's food operations.

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(without coumarin)

A substitute for coumarin at equal strength. $3.00 per lb.

Also its companion, TONKASYN AMORPHOUS, twice the strength of coumarin at $6.00 per lb.

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FOOD INDUSTRY TOPICS

Ralph A. Rockwell has been appointed chief engineer for the Valve Division of Minneapolis-Honeywell Regulator Co., it was announced by Mr. M. B. Taft, general manager. Mr. Rockwell, a veteran of some 30 years experience in the instrument and control industry, will continue to serve as advisor to the Division's sales and engineering departments, coordinating the design, application, and production of industrial valves.

◆ ◆ ◆

Mr. Howard A. Prentice of Washington. D. C., vice president of the Corn Industries Research Foundation, Inc., was elected president of the American Trade Assn. Executives at their 1954 annual meeting in November. The new ATAE president, an IFT member, is a trustee of the University of Vermont and State Agricultural College, consultant for industrial organizations, and a member of the Trade Assn. Department Committee, U. S. Chamber of Commerce.

◆ ◆ ◆

Dr. Walter O. Lundberg, executive director of the Hormel Institute, and professor of agricultural biochemistry at the University of Minnesota, has been elected chairman of the American Chemical Society's Division of Agricultural and Food Chemistry, succeeding Dr. C. S. Boruff. **Dr. Albert L. Elder,** director of research of Corn Products Refining Co., was chosen chairman-elect, and **Prof. F. M. Strong** of the University of Wisconsin was named secretary-treasurer. A member of ACS since 1943, Dr. Lundberg is also a member of the AAAS, the American Oil Chemists' Society, the American Society of Biological Chemists, IFT, and the New York Academy of Sciences.

◆ ◆ ◆

Mr. Charles E. Brooker has succeeded Mr. S. H. Crounse as sales manager of the Pennsylvania Salt Mfg. Company's Food Industries Department. He will direct distribution of Pennsalt's line of cleansers and sanitizers for milk plants, dairy farms, beverage plants, and other food processing industries. Since becoming a member of Pennsalt, Mr. Brooker contributed materially to development of Bry-Ko, B-Kleer, and Raydex, the firm's newest sanitizing products. The appointment was made known at a dinner honoring Mr. Crounse's outstanding contribution to the dairy industry during 40 years of service with Pennsalt.

◆ ◆ ◆

Magnus, Mabee & Reynard, Inc., international essential oil firm, announced appointment of **Mr. W. Warfield Graves, Jr.,** as company representative in Michigan and surrounding areas. Mr. Graves was previously engaged as a sales representative with leading pharmaceutical companies in the Midwest. His headquarters will be in Royal Oak, Mich.

◆ ◆ ◆

Dr. Alexander Katz, head of F. Ritter & Co., Los Angeles flavor firm, accompanied by his grandson, Donald, returned recently from a 9-week flying trip through Europe and the Near East. While in Israel, where they were guests of the Israeli Chemical Combine, Dr. Katz worked with the technicians in the thriving citrus, flavor, and essential oil industries. He was also a guest of the faculty members of the University of Jerusalem and and the Technical College of Haifa. After re-visiting his alma mater, the University of Lausanne in Switzerland, Dr. Katz visited Holland to establish business connections, and England where he contacted sales connections.

EMPLOYMENT NOTICES

AVAILABLE: Food Technologist—B.S. Experience in Quality Control and Production of Tomato Products, Fruit Juices, Concentrates, Jellies, and Preserves. Interested in position requiring initiative, imagination and responsibility. REPLY BOX 380, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist. Young Technologist for control and development work by manufacturer of food specialties, location Western New York. Send resumé of training and experience to BOX 379, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist for Research and Development on cooked frozen foods and poultry by-products. Want man with experience and a good record of accomplishments. Salary open commensurate with qualifications. REPLY BOX 381, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

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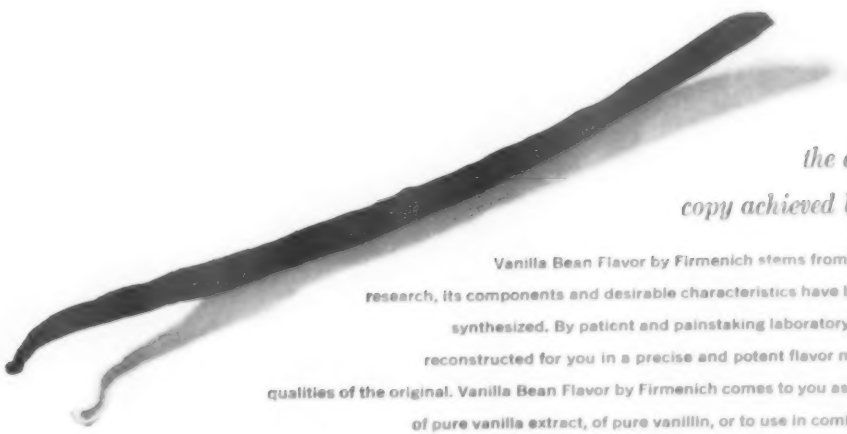

the direct and authentic
copy achieved by original research

Vanilla Bean Flavor by Firmenich stems from the vanilla bean. By original research, its components and desirable characteristics have been isolated, identified, and synthesized. By patient and painstaking laboratory techniques, they have been reconstructed for you in a precise and potent flavor material with all the aromatic qualities of the original. Vanilla Bean Flavor by Firmenich comes to you as an economical replacement of pure vanilla extract, of pure vanillin, or to use in combination, in the manufacture of all products that you flavor with this most popular of flavors.

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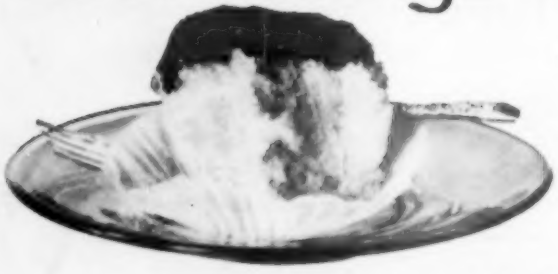
If you want to lose business, and do without,

Use Strawberry Flavor

whose taste fades out.

NORDA Flavors don't fade out,

So... always come to NORDA



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